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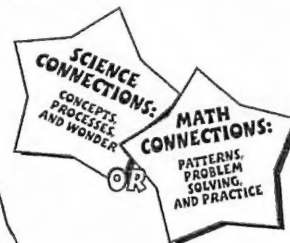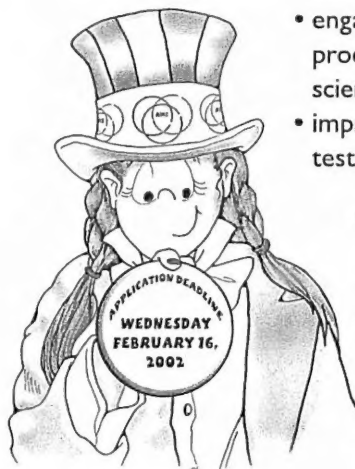
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Isn't It Interesting...
Let the Games Begin

Two different American hockey teams came to the 1948 games, each insisting that it represented the USA. In the end, it was decided that neither would be eligible for a medal.

Speed skating is the fastest human-powered sport in the world. World-class speed skaters can reach speeds of 40 mph or more.

Biathlon is one of the world's oldest sports, dating back to 3000 B.C. However, it did not become an Olympic sport for many years because of its connection to military history.

The first bobsleds were made of two long toboggans fastened to a wooden plank with pivots. As many as six people could ride lying down, one steering with a rope and one dragging a garden rake for a brake.
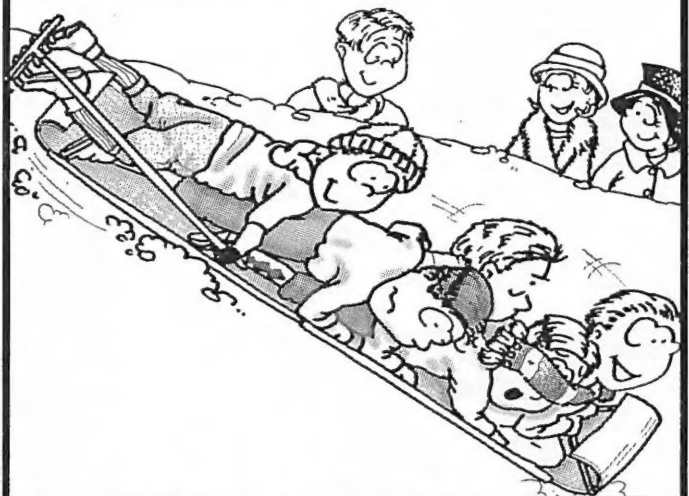
The Teachable Moment

by Suzy Gazlay

Winter Olympics

The history of the Olympic Games dates back at least as far as 776 B.C. The modern version was established in 1896 to encourage amateur athletics and promote world peace.

Winter sports did not originally have a place in the Olympic Games, since the games were held during the summer. In 1908, the London Olympics featured figure skating, which had already become quite popular in England. The competition could take place in a rink and thus did not require winter weather. The skating events were very successful, so ice hockey, which could also be held in a rink, was planned for the 1916 Olympics. As it turned out, those games were canceled because of World War I, so the first Olympic ice hockey games were played at the 1920 Olympics in Belgium. Other winter sports such as skiing and bobsledding were becoming increasingly popular in Northern Europe and the Alps. Clearly these sports could not compete indoors, so officials began considering the possibility of holding Winter Olympics as well as the summer games.

In 1924, the year the summer games were held in Paris, the town of Chamonix in the French Alps hosted a winter festival. Not everyone agreed that the festival should be an official part of the Olympics—particularly the founder of the modern Olympics—so a compromise was reached and the event was called the "Olympic Winter Festival." Nearly 300 athletes from 16 countries came to compete in five events: bobsledding, hockey, speed skating, figure skating, and Nordic skiing. The festival was such a success that four years later the Winter Olympics were formally established.

The initial idea was to hold both summer and winter games in the same country. However, not every country has suitable winter facilities, as was the case with Holland, the host of the 1928 summer games. So, the first official Winter Olympics were held in St. Moritz, Switzerland, attracting 500 athletes from 25 countries.

At the next Olympic games in 1932 both summer and winter events did take place in the same country, the USA. Four years later, Germany hosted both events, and Alpine skiing for both men and women was added to the program. The games were not held in 1940 or 1944 because of World War II. Ever since they resumed in 1948, they have been held in two separate countries, usually on two different continents.

Insufficient snow nearly canceled the 1952 winter games in Oslo, but fortunately a storm moved in just in time. That year, cross-country skiing for women and giant slalom were new events. To the surprise of many, the 1960 games were held in the tiny and scarcely known resort of Squaw Valley, California, rather than at a more famous resort in Austria. The biathlon event was added that year.

The 1980 Winter Olympics in Lake Placid, New York, proved to be one of the most exciting for Americans. Eric Heiden won gold medals in all five men's speed skating events. In the process, he set five Olympic records and two world records. The US hockey team unexpectedly won the championship. Other American athletes were awarded four silver and two bronze medals.

In 1992, short-track speed skating and freestyle skiing events were added to the games in France. These were the last Winter Olympics to take place the same year as the summer games. The next Winter Olympics were held just two years later in Norway and planned for four-year intervals from then on. In 1998, the games in Japan got off to a shaky start literally with a mild earthquake and inclement weather—fog, wind, rain and lightning—before good weather returned. Olympic competitions in curling, women's ice hockey, and snowboarding, a relatively new sport, took place for the first time.

Interesting Facts

- The first gold medal of the first Winter Olympics was won by an American, Charles Jewtraw, for the 500-meter speed skating event.
- Norwegian Sonia Henie was only 15 when she won the first of her three consecutive gold metals in figure skating in 1928. She was the first woman athlete to become an international sports figure.
- There was so little snow for the 1956 Winter Olympics in Italy that the Italian army had to truck in snow from higher up in the Alps and rearrange it with the little that was already there. In 1964, the process was repeated in Austria, but this time the army got some help from six snowmaking machines flown in from the USA.
- Snow was also seriously lacking in Squaw Valley prior to the 1960 Olympics. Worried officials hired a group of Native Americans to do a snow dance. It rained hard instead, but the storm kept the President from arriving, delaying the opening ceremonies. During the delay, it finally snowed.
- The 1960 Olympics were the first to be televised.
- In 1998, 15-year-old figure skater Tara Lipinski landed seven triple jumps and replaced Sonia Henie as the youngest Winter Olympics gold medalist ... so far.
- Bonnie Blair, an American speed skater, won a total of six gold medals, five of them for individual events. That's more than any other female speed skater or any other Olympian woman competing as an individual.
- The United States has won Olympic medals in all but three sports: biathlon, luge, and Nordic combined skiing.
- A four-person bobsled can go as fast as 80-90 mph, with as much as four G-forces on the curves.

- In 1932, then-governor Franklin D. Roosevelt opened the Olympic Games. His wife, Eleanor, took a run on a bobsled.
- Curling is sometimes called "The Roarin' Game" because of the noise made by the stone as it rumbles down the ice.
- A stone engraved 1511 (A.D.) and found in a Scottish marsh may be one of the first curling stones.
- U.S. figure skaters have won more Olympic medals (40) than any other country in history. Additionally, the U.S. has won at least one medal in 14 consecutive Olympic Winter Games.
- Freestyle skiing was once known as "hotdogging."
- Some hockey players can shoot the puck as fast as 90 to 100 mph. Speeds have been recorded up to 120 mph.
- Luge gets its name from the French word for sled or toboggan.
- Luge sleds have no brakes and they can reach speeds as fast as 90 mph.
- The two most precisely timed Olympic sports are the luge and speed skating, both of which are timed to the nearest one-thousandth of a second.

Things to Do
- Research to find the sites of all the Olympic games so far. Locate and mark them on a world map, using one color for winter games and another color for summer games. Construct problems using the data.
- A bobsled moving 60 mph covers 9.5 inches in one hundredth of a second. Use this data to create related math problems. Research to find speed and distance statistics for other winter sports.
- Freestyle aerialists refer to the time they are airborne as "catching air." They go as high as 60 feet. Here are some other sports-related heights to compare:
    Springboard diving board: 9'10" above water
    Platform diving board: 32'9" above water
    High jump: 8 feet, 0.5 inch (Javier Sotomayor, Cuba, world-record holder)
    Pole vault: 20 feet, 1.75 inches (Sergei Bubka, Ukraine, world-record holder)
Measure and compare these distances to get an idea of the distances involved. Research other sports records and add the data to the comparison.
- Keep track of the team scores and standings during the Winter Olympics. Chart or graph the data and create various math problems.
- Research to learn which countries are participating in the 2002 Winter Olympics. Locate each country on a world map.
- Snowboarding has been described as a cross between skateboarding and skiing. Find out more about the various tricks done by snowboarders. Make a list and compare them to those done on skateboards and skis.

Literature Connections
For students
Brimner, Larry Dane. *Snowboarding (First Books)*. Franklin Watts, Incorporated. New York. 1997.

Brimner, Larry Dane. *Bobsledding and the Luge (True Books—Sports)*. Children's Press. Danbury, CT. 1997.

More Winter Olympics books by Larry Dane Brimner from Children's Press.
The Winter Olympics (1997)
Skiing (1997)
Speed Skating (1997)
Figure Skating (1997)

Yamaguchi, Kristi, and Greg Brown. *Always Dream (Positively for Kids Series)*. Taylor Publishing Co. Dallas. 1998.
Gold medalist's story of determination and love for skating.

Reference
Benson, Lee and Susan Eston Black. *Salt Lake 2002: An Official Book of the Olympic Winter Games*. Shadow Mountain. Salt Lake City. 2000.

Italia, Bob; Paul Joseph, and Robert Italia. *100 Unforgettable Moments in the Winter Olympics*. ABDO Publishing Co. Edina, MN. 1996.

Marsh, Carole. *A Fun Book of Olympic Trivia : A to Z! Speical Advance Edition. 2002 Winter Olympics, Salt Lake City, Utah*. Gallopade International. Peachtree City, GA. 1994.
Also available on computer disk.

Wallechinsky, David, *The Complete Book of the Winter Olympics, 2002 Edition)*. Overlook Press. New York. 2001.
Statistics, history, scores, stories from past Olympics, and listings of athletes in the 2002 games.

Resources
U.S. Olympic Committee
One Olympic Plaza
Colorado Springs, CO 80909
719-632-5551

Internet Connections
Overview of history of Winter Olympics
http://www.hickoksports.com/history/winterol.shtml

Highlights of all the past Winter Olympics
http://www.infoplease.com/ipsa/A0115110.html

Official website of the 2002 Winter Olympics in Salt Lake City, Utah
http://www.slc2002.org/

WINTER OLYMPIC SPORTS

SNOWBOARD

Snowboard competition consists of two parts: alpine (giant slalom) and half-pipe (freestyle). All competitors race in both events, and the scores are combined. The alpine portion is a timed event in which snowboarders push off and race through a series of triangular gates (stubbies). If a gate is missed, the rider must go back and complete it before going on. The halfpipe event features snowboard tricks (hits) performed off the rim of the pipe, a large trough in the snow. Each rider drops into the pipe and executes whatever hits he or she chooses. Competitors are judged for such factors as technique, degree of difficulty, number of hits, height, rotation, and landing. After a qualifying round, finalists compete in two races for the best combined score.

BOBSLED

Bobsled events feature two-person and four-person teams, as well as individual competition. Team members push the sled into motion at the top of a winding ice-covered downhill track, then jump in and steer it down the course. Each team has a pilot and a brakeman; the four-member teams also have two pushers. A skeleton is a one-person sled with no steering mechanism. After a running start, the slider (competitor) dives head first onto the sled, using body pressure and feet to steer. Participants race individually for the best time, measured to one-hundredth of a second. Combined scores from four separate runs determine the winner. Women's bobsled and skeleton will be Olympic events for the first time at the 2002 Winter Games.
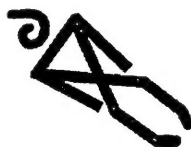
LUGE

Luge competition demands both endurance and consistency. The singles events consist of four separate runs over a two-day period, but the doubles events have just two runs. Each is clocked to the nearest one-thousandth of a second. The final score is the total of all runs.

Each run begins with the luger (or team) sitting on a motionless sled at the top of the starting ramp. Then, pushing off hard from two fixed handles, the luger rockets feet first down the icy slope. The timing of the race begins when the luge crosses an electronic eye at the base of the starting ramp and ends when it crosses the timing light at the bottom of the run—if the luger is still in contact with the sled. Lugers can crash, recover, and continue during a race and not be disqualified, as long as they finish the race with the sled.

FIGURE SKATING

Figure skating includes four events: men's singles, ladies' singles, couples, and ice dancing. The singles and couples competitions include a short program including certain mandatory components, timed to be no longer than two minutes and 40 seconds, plus a free program of their own design. Ice dancing has three parts: two compulsory dances and a free dance. It is different than the other competitions in that it emphasizes using dance steps to interpret rhythm and tempo rather than the jumps and lifts that characterize the singles and pairs events.

SPEED SKATING

Speed skating competition consists of five events for men and five for women. The length of each race ranges from 500m to 5000m for women and from 500m to 10,000m for men. Long track skaters race the clock for the fastest time, measured to one-hundredth of a second. Short track skaters race against each other. Rules require competing skaters to switch places from the shorter inside lane to the outside lane once during each lap. Relay teams consist of four skaters who can trade off whenever they want to, as long as the last two laps are skated by just one person.

ICE HOCKEY

Ice hockey features two teams of six players, all on skates. The object of the game is to get the puck into the opponents' net while defending their own net against the opponents' attempts to score. Ice hockey players use a hockey stick and wear extensive protective gear.

CURLING

Curling requires strategy as well as skill. Two four-player teams competing on a long, thin stretch of pebbled ice play it. Each team's goal, or house, consists of a series of concentric circles, the largest measuring 12 feet across. Every player propels two 42-pound highly-polished granite stones from a starting point, or hack, into the house of the defensive team. The stone is released with a spin or "curl." While it is traveling, two members of the curler's team may use brooms to sweep the ice in front of it, smoothing the ice and thus adding as much as 15 feet to the stone's path.

Although everyone launches two stones towards the goal in each round, only the offensive team can make points. The goal and direction switch after each round. The teams alternate turns, each curler trying to get as close as possible to the center of the house, perhaps knocking away an opponent's stone, or blocking and protecting a stone from their own team. At the end of the round, a point is given for each stone between the center of the ring and whichever opposing stone is closest to the center of the house.

CROSS-COUNTRY SKIING

Cross-country skiing consists of ten events: four individual races and one relay race each for men and for women. Two individual races, long and short courses, are run in classic cross-country form, and two (also long and short) are run in freestyle, which means that the skier can use whatever style he or she chooses. The relay teams consist of two members who ski classic style and two who ski freestyle.

BIATHLON

Biathlon is a combination of cross-country skiing and rifle marksmanship. Competitors race around a course measuring 20 km for men or 15 km for women, stopping at designated intervals to shoot five rounds at a target. At the first target, the shooting is done from a prone position; at the next, the biathlete stands to shoot. As they approach a target, biathletes intentionally slow down and lower their breathing and heart rates, then shoot at the target between breaths. There are three biathlon events: individual (longer course, four targets), sprint (shorter course, two targets), and relay (four to a team, two targets each). For each target missed, individual competitors are penalized by adding to their time; relay team members must ski an additional 150 meters.

SKI JUMPING

Ski jumping includes three events: individual normal hill, individual large hill, and four-person team large hill. Each skier gets two jumps, during which both style and distance are evaluated. The landing should be with one foot in front of the other, knees bent, and arms spread for balance. Points are given for landing at a designated spot, and more are added for going beyond it—or subtracted for landing short. Each jump is also evaluated for style (power, boldness, precision, fluidity and control) of the takeoff, flight, landing, and the rest of the run.

NORDIC COMBINED

Nordic combined includes both individual and team events over a two day period. On the first day the Nordic athletes compete with two jumps. On the second day, individual competitors ski cross-country.

FREESTYLE SKIING

Freestyle skiing focuses on two elements. The first is moguls, run downhill on a steep, lumpy slope. Skiers are judged for a combination of technical turns, "air" (aerial maneuvers in which the skier is judged for execution of the jump, height, distance, landing, and degree of difficulty), and speed. Each judge is given a certain part of the run to evaluate. After the initial qualifying run, the top 16 competitors move on to a final run, on which they are evaluated for a final score. The second event is aerials. Each skier is allotted two different acrobatic jumps in each round. Each is evaluated according to takeoff, height, distance, execution, precision/form, landing, and degree of difficulty. Again, each judge is responsible for watching a certain part of the jump rather than the entire thing. After the first round, the top 12 competitors move on to a second round also consisting of two different jumps. The winning score is determined by combining the different elements according to a mathematical formula.

ALPINE SKIING EVENTS

Alpine skiing events include five races each for men and for women.

DOWNHILL

The Downhill event is a single run for the fastest time. In the quest for great speed, this can be a dangerous event. Skiers are required to participate in an official training run before the race in order to experience the conditions. The course must be free of obstacles and not too steep to slide down without using poles. If the skiers are going too fast for safety, officials are allowed to place control gates to slow them down.

SLALOM

Slalom racers have two runs down the same slope on the same day, but using two different courses set side by side. Each course is steep and marked with red and blue flags. The skiers must execute tight, controlled turns while skiing very fast. They must go through all gates with both ski tips and both feet, but they may use their bodies to push the gates aside. If a gate is missed, the skier is disqualified from both runs. Before the race, the skier may sidestep up the course to get a closer look at it, but he or she is not allowed a practice run. The combined score of both runs determines the winner.

GIANT SLALOM

The Giant Slalom is similar to the slalom but longer and less pre-scribed. The number of gates is determined by the steepness of the slope, and there is a greater distance between the gates. Like the slalom, there are two runs, each taken on a different course set on the same slope, and the times of both runs are combined. Competitors have an hour before the race to side step down the course and take a look at the gates, but they may not go through any gates or practice any turns.

SUPER-G

The Super-G is a combination of downhill and giant slalom, shorter than a downhill course, but longer than a giant slalom. The men's course has 35 gates and the women's has 30, all set at least 25 meters apart. The skiers are allowed to study the run on the day of the race, but they cannot practice it. Each skier gets just one run to try to achieve the fastest time. Anyone who misses a gate is disqualified.

COMBINED

The Combined event consists of one downhill and two slalom runs with the same rules as hold for the downhill and slalom events.

SLIP SLIDING SLEDS

by Carol Gossett

Topic
Force and motion/friction

Key Question
What kinds of materials can you use to build a model sled that will win the class Olympic sled races?

Learning Goals
Students will:
1. begin to develop an awareness of the effects of friction,
2. relate their findings in model sled races to the events of the Winter Olympic, and
3. apply their knowledge and vocabulary of ordinal numbers as they announce the standings of their sleds in the various sled races.

Guiding Documents
Project 2061 Benchmarks
- *Things move in many different ways, such as straight, zigzag, round and round, back and forth, and fast and slow.*
- *Some kinds of materials are better than others for making any particular thing. Materials that are better in some ways (such as stronger or cheaper) may be worse in other ways (heavier or harder to cut).*
- *Many of the toys children play with are like real things only in some ways. They are not the same size, are missing many details, or are not able to do all of the same things.*
- *A model of something is different from the real thing but can be used to learn something about the real thing.*

NRC Standard
- *An object's motion can be described by tracing and measuring its position over time.*

NCTM Standards 2000*
- *Develop understanding of the relative position and magnitude of whole numbers and of ordinal and cardinal numbers and their connections*
- *Sort and classify objects according to their attributes and organize data about the objects*
- *Represent data using concrete objects, pictures, and graphs*

Math
Counting
    ordinal numbers

Science
Physical science
    force and motion
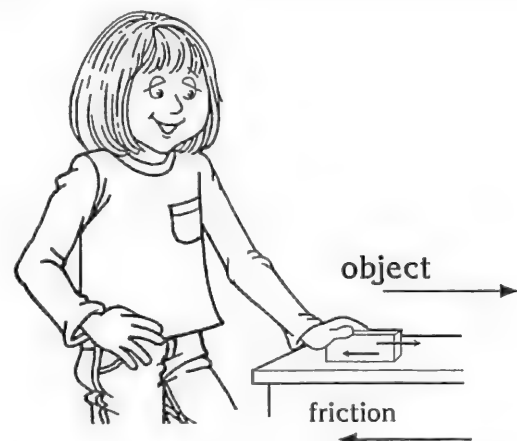   friction

Integrated Processes
Observing
Predicting
Collecting and recording data
Comparing and contrasting
Drawing conclusions
Applying

Materials
Pans of ice (see *Management 1*)
Various runner materials (see *Management 2*)
Index cards
Transparent tape
Rulers
Freezer
Class prediction graph
Class recording chart
Student recording strips
Chart paper

Background Information
If we slide or try to slide an object over a surface, a force between the object and the surface resists the motion. The resistance is called the frictional force or more commonly friction. Friction is a force that acts in the direction opposite to the direction of the motion of the object.

object

friction

In *Slip Sliding Sleds*, students will explore the effects of frictional forces caused by sled runners made of different materials as the sleds move across the surface of ice ramps. As the runners of the bobsleds slide down an iced surface, friction acts against the runners in the opposite direction the sleds are moving and causes the sleds to slow down. The strength of this force is dependent on the types of materials the runners are made from. Some materials will result in greater frictional force than others. The greater resistance indicates a stronger frictional force. Using different types of materials for the runners can change the strength of these frictional forces. To simplify the concept of friction for the young learner, it is suggested that the teacher introduce friction as a force that pushes against the sleds.

This lesson allows students to relate to the bobsleds used in the Winter Olympics. The models are not exactly the same as the real bobsleds; however, they can be used to learn something about the actual sleds.

Management
1. Prior to the lesson, freeze one large shallow pan (e.g., jelly roll pan) of ice for each group of students. These will be used as ramps on which students will race their bobsleds.
2. Gather various materials such as wooden craft sticks, plastic straws, large metal paper clips, and pipe cleaners. These will be used to construct runners on the bobsleds.
3. Depending on the abilities of your students, you may need to construct the bobsleds prior to the lesson or invite cross-age tutors or parents to the class to help in the construction of the sleds. (See *Sled Construction Instructions*.)
4. Enlarge the *Class Prediction Graph*. Duplicate one *Student Explanation* strip per student.
5. Enlarge the class results chart or make a transparency of this page and project it so that all the students can easily read the chart.
6. Optional: If possible, prior to the lesson, locate a video of a bobsledding event held during the Winter Olympics or other pictorial resources for students to view the sport of bobsledding. See *Curriculum Correlation* for suggested resources for information on bobsledding.

Procedure
Part One
1. Introduce the sport of bobsledding to the class either by viewing the event on television during the Winter Olympics or by showing a video featuring the event. Discuss how the bobsled is similar to sleds typically used by children to slide down snow-covered hills. Explain that the bobsleds are designed to travel very fast down ice-covered tracks.

2. Discuss the construction of the sleds by pointing out the runners or blades on which the sleds ride. Ask students if they think what the runners are made of would make any difference in the speed of the sleds. Discuss why they think this.
3. Explain that they are going to construct some model bobsleds and will be testing a variety of runners that are made from different materials.
4. Divide the class into groups of four. Assign a cross-age tutor or parent helper to each group. Guide the class and helpers as they construct the bobsleds. Display the different types of materials provided to build the runners. Ask each student in the groups to choose a different material from which to make the runners. Each group will have four sleds, all with different types of runners.

Part Two
1. Before the races, discuss the different materials that were used to construct the runners on the bobsleds. Discuss how some are made of metal, others of wood, plastic, and fabric.
2. Distribute a sample of each of these materials. Ask students to pass these around for each student to touch and examine closely.
3. On chart paper, ask students to list attributes of these materials. [smooth, rough, thick, thin, etc.] Discuss whether or not any of these attributes may or may not make a difference in the speed of their bobsleds. Ask students to explain their thinking.
4. Introduce the term *friction*. Discuss how friction, in this case, will slow their bobsleds down. Explain that when two materials rub against each other, there is a force called friction. In this lesson, the frictional force will push against the bobsled runners slowing the motion of the sleds. Explain that different materials will cause more or less friction on the surfaces they are rubbing against. Suggest that through their bobsled races, the students will be able to explore which runners have the least and most friction when sliding against ice ramps.
5. Ask students to predict which runner materials will let the sleds go the fastest because they have the least friction. Have students record their predictions on the class graph by signing their names in the appropriate spaces. Distribute the *Student Explanation Strips* and have them explain their predictions. Ask them to explain why they chose the type of runner materials they marked on the graph for their predictions.
6. Have students share their predictions and their explanations. Engage the class in a discussion about the different ideas shared.

Part Three

1. On race day, bring in ice ramps for the class. Store these in a freezer until the class is ready to begin the race.

2. Elevate the ice ramps about 10 centimeters (four inches) by placing boxes, books, or other objects under one end of the ice ramps. (The lids from copy paper boxes work well.)

3. Use a ruler placed on the ice to divide the ramp in half and to designate one lane for each bobsled in the race. Use another ruler to hold the bobsleds at the top of the ice track until the race begins. Tell the students when the race begins, to lift the top rulers, releasing both sleds at the same time.

4. Have students take turns racing two sleds at a time. Tell them to race each sled against all other sleds in their group, a minimum of three times. Ask students to keep track of their results and to be ready to share them with the class. Ask students to record the results of the races using the ordinal numbers: first, second, third, and fourth. Explain that they must look at all the races and determine the order in which to place their sleds based on how each one did against the others. They will need to report which runners they found to have the least resistance or frictional force (the fastest) and those that had the most resistance or frictional force (the slowest).

5. After all races have been completed and the results have been recorded, gather the class for a time of sharing and discussion.

6. Ask reporters from each group to announce the results of the races from their groups. Record these results on the class chart noting which type of bobsled runner came in first, second, third, and fourth in the races.
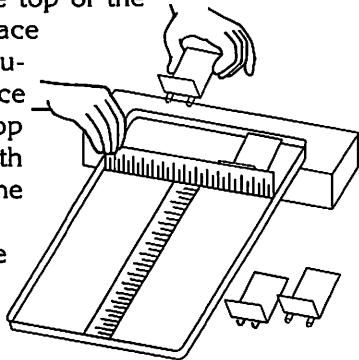
Class Results Chart

Group		1st	2nd	3rd	4th
	1	metal	plastic	wood	fabric
	2				
	3				
	4				
	5				
	6				

7. Discuss the attributes of the runners that were the fastest as well as those that proved to be the slowest. Compare the materials used to build these runners.

8. Ask students to draw conclusions about the different materials and what they learned about friction. Discuss how things that are rough have more resistance or frictional force on ice than things that are smooth. Talk about how when the runners slid along the surface of the ice ramps, the frictional force pushed against the runners to slow them down. Discuss how the pipe cleaner runners had more resistance than the plastic straw runners, and that the metal runners had less resistance than the wooden runners, etc.

9. Compare the results of the tests with the predictions previously made. Have students review their *Student Explanation Strips* and discuss any new discoveries they have made about friction and its effects.

10. Review the information from videos, programs on television, or through the *Curriculum Correlation Resources* that were previously presented to students about the sport of bobsledding. Ask students to relate their findings in this lesson to the bobsleds used in the Olympics. Discuss how runners on the Olympic sleds are all made of smooth metal and thus have very little resistance or frictional force against the ice ramps allowing them to travel at speeds up to 80 miles per hour—faster than the cars on a highway are supposed to go!

Discussion

1. Ask students to describe how the model sleds are similar to and different from actual bobsleds.

2. Which bobsled slid the fastest? What type of runner did it have?

3. Which bobsleds came in second, third, and fourth? What kind of runners did these sleds have?

4. Did any of the bobsleds not slide at all? What type of runners did they have?

5. Why does the type of runner make a difference in how the bobsleds slide? [Some materials cause the sleds to move slower than others do.]

6. What caused one bobsled to be faster than another? [the amount of frictional force or resistance, the type of material of the runner]

7. Do you think the materials used for the runners would still make a difference if the sleds were sliding down something other than ice? Explain why you think this.

8. What other events in the Winter Olympics deal with frictional forces similar to the bobsled races? [ice skating, luge, snow skiing, curling] Explain how friction affects these events.

Extensions

1. Bring in a child's sled and compare the con-struction and materials of which it is made to that of an Olympic bobsled. Discuss the places where frictional forces affect the children's sled. Discuss how these forces may be changed. [by changing the surface materials that slide on the ice surface]
2. Bring in other snow toys such as saucers, tobog-gans, innertubes, etc. Have students examine these and discuss the places where frictional forces affect the ride on these toys.
3. Expand student's knowledge about the sport of bobsledding and the luge by sharing the book *Bobsledding and the Luge* and by visiting sites on the Internet that discuss all Winter Olympic events. (See *Curriculum Correlation.*)

Evidence of Learning

1. Listen for understanding as students discuss the results of their bobsled races.
2. Look for appropriate use of the term friction as students explain their observations and conclu-sions.
3. Listen for appropriate use of the terms first, second, third, and fourth as students report their race results.

Curriculum Correlation

Literature

Brimner, Larry Dane. *Bobsledding and the Luge (True Books - Sports).* Children's Press. New York. 1997. (This book written for ages 9-12 begins with the his-tory of bobsledding and the luge and then describes aspects such as the mechanics, competitive ele-ments, special Olympic moments, etc. The pictures capture the speed and motion of bobsledding.)
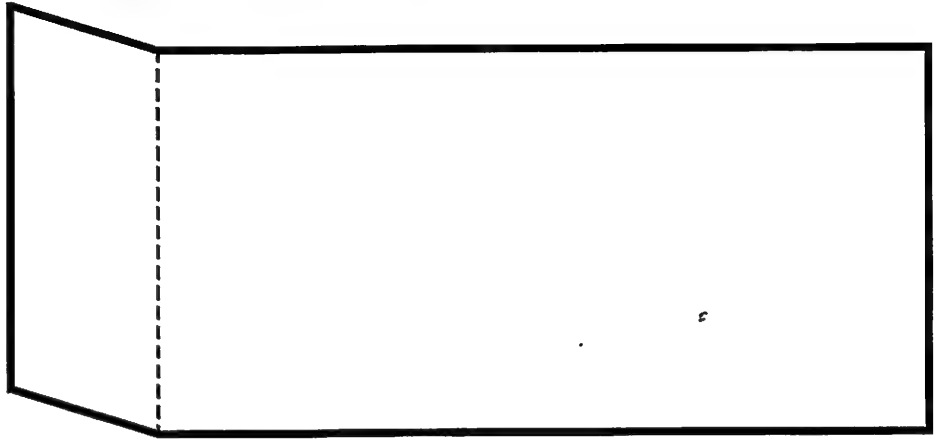
Resources

Sports and Disciplines of the Winter Olympic Games http://southflorida.digitalcity.com/DCSports/ olympics/explaine.htm (This website includes dia-grams and explanations of interesting information about each event in the Winter Olympics.)
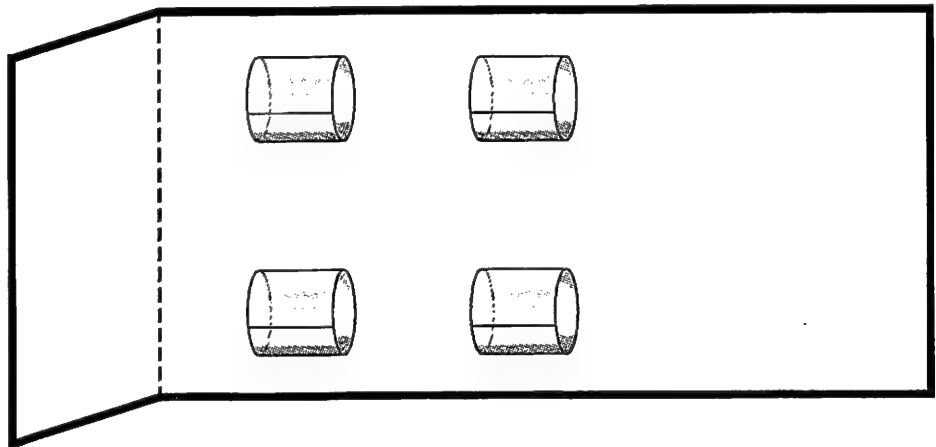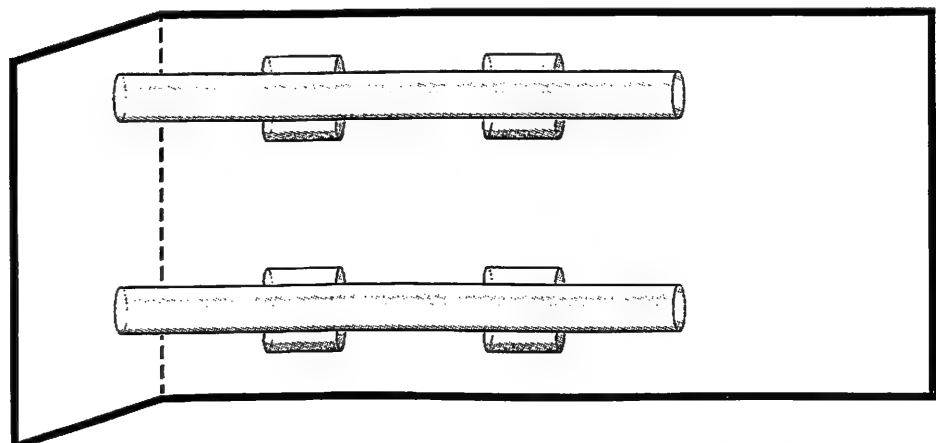
Sled Construction Instructions

1. Cut one index card 10 cm long and 5 cm wide. Bend up one end 2 cm.

2. Roll transparent tape and place on the underside of the card where you want to position the runner materials.
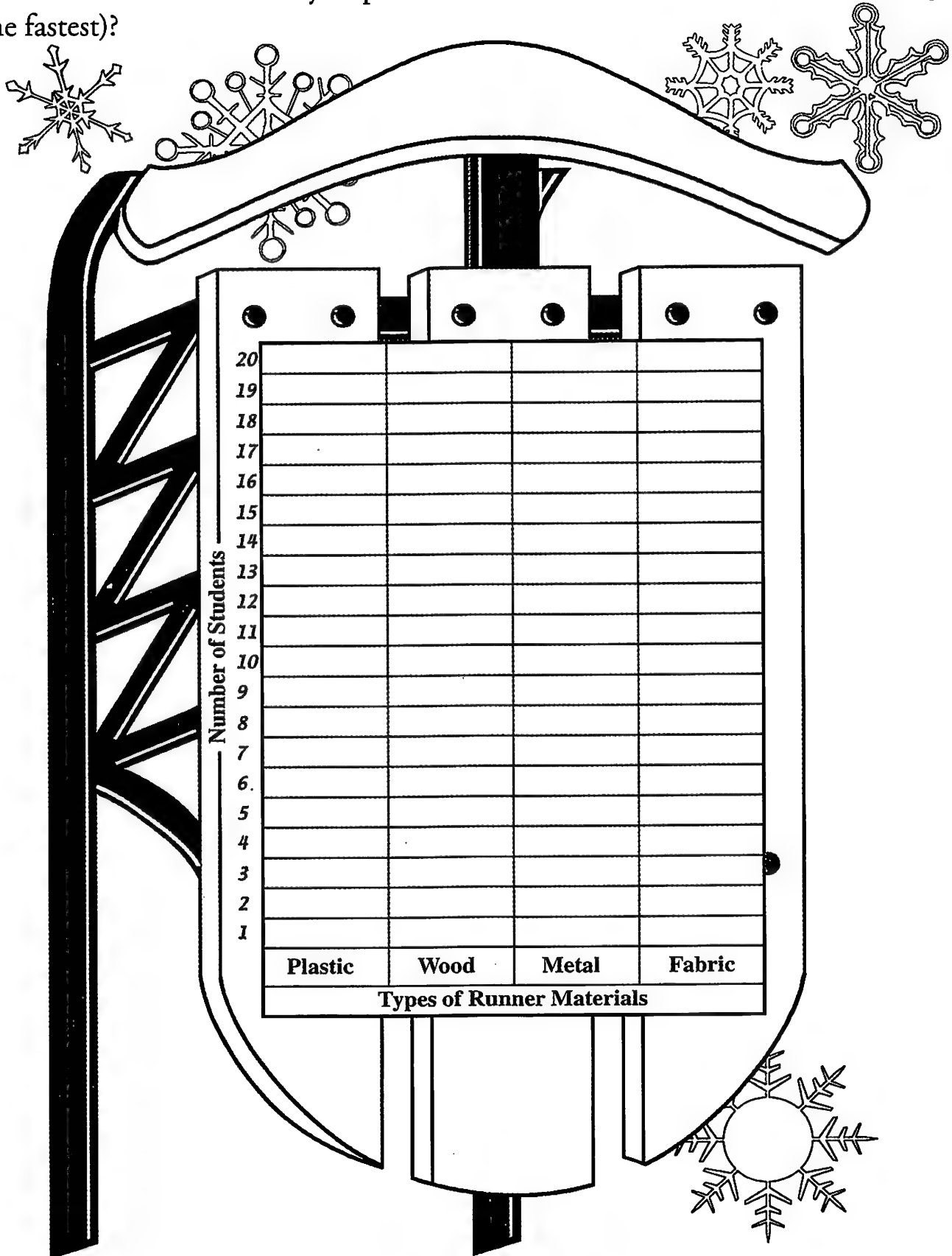
3. Place two runners on top of the tape rolls on each card.

Class Prediction Graph

Which runner material do you predict will have the least amount of friction (goes the fastest)?

Number of Students	Plastic	Wood	Metal	Fabric
20				
19				
18				
17				
16				
15				
14				
13				
12				
11				
10				
9				
8				
7				
6				
5				
4				
3				
2				
1				

Types of Runner Materials

Student Explanation Strips

I
think
...

I
think
...

I
think
...

Class Results Chart

Group	1st	2nd	3rd	4th
1				
2				
3				
4				
5				
6				

2nd
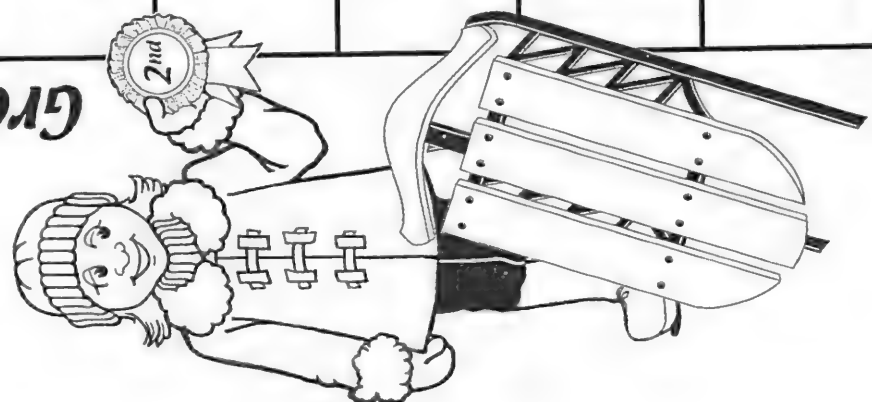
PARK CITY SNOW

Park City, Utah, just above Salt Lake City, is the site of the giant slalom and other events of the 2002 Winter Olympic Games.

Materials
Adding machine tape
Meter stick or tape
Scissors
Tape

How does the snow depth at Park City compare to your height?

The normal snow depth* at Park City for the third week of February is 209 cm on the upper slopes and 154 cm on the lower slopes.

Measure and cut pieces of adding machine tape, one representing the snow depth of the upper slopes and another for the lower slopes. Label the two strips and attach to a wall, side by side, starting at the floor. Stand beside them to compare.

How does this year's snow depth compare with normal snow depth?

During the Olympics, find the current snow depth at the upper and lower slopes and cut two new corresponding strips of adding machine tape. To compare, attach next to the normal snow depth strips. Since this is a direct comparison, it does not matter whether measurements are in centimeters or inches.

The following websites may help with your data search:
International Olympic Committee   http://www.slc2002.org
National Weather Service   http://www.wrh.noaa.gov/Saltlake/
Snow-forecast.com   http://www.snow-forecast.com/

* This weekly average is based on eight years of data. Elevations are not specified.
  Source: http://www.skiclub.co.uk/.

an Olympic Latitude

by David Mitchell and Ann Wiebe

Topic
Geography and sports

Key Question
How does a country's latitude position influence the number of medals won at the Olympics?

Learning Goals
Students will:
1. locate and plot the countries that won the most Olympic medals during the most recent summer and winter games,
2. look for patterns, and
3. suggest reasons why latitude may influence why some countries are more successful during the winter games than summer games.

Guiding Documents
Project 2061 Benchmarks
• *Geometric figures, number sequences, graphs, diagrams, sketches, number lines, maps, and stories can be used to represent objects, events, and processes in the real world, although such representations can never be exact in every detail.*
• *Offer reasons for their findings and consider reasons suggested by others.*

NCTM Standard 2000*
• *Propose and justify conclusions and predictions that are based on data and design studies to further investigate the conclusions or predictions.*

National Geography Standards
• *Use maps to observe and interpret geographic relationships*
• *Identify opportunities that the physical environment provides for people*
• *Identify ways in which human activities are constrained by the physical environment*

Math
Data analysis

Science
Earth science
    weather

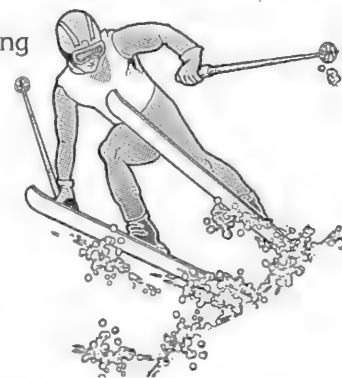**Social Science**
Geography
    world
    map skills
        latitude

Integrated Processes
Observing
Recording data
Comparing and contrasting
Interpreting data
Seeing relationships
Inferring
Drawing conclusions

Materials
For each group:
    colored pencils
    atlas

Background Information
The XIX Olympic Games will be held in Salt Lake City in February 2002. The games are held every four years. An Olympiad is defined as a period of four years, the beginning of which is marked by the celebration of the Olympic Games. The first modern Olympiad was celebrated at the 1896 Athens Games. Each Olympiad is designated by Roman numerals. The 2000 Sydney Games were the Games of the XXVII Olympiad. The term Olympiad does not apply to the Olympic Winter Games. Only the so-called "summer" games are Games of the Olympiad. The Winter Games are referred to only by numeral.

All athletes in the Olympic Games participate as representatives of their countries. Olympic team members are usually selected through national Olympic qualification competitions. In the sport of track and field, for example, the top three finishers in each event at the USA Track and Field Olympic Trials are selected to the Olympic team. In some sports, national federation officials select national teams. They base the decision on current fitness, past performance, and future potential. Each sport determines how its athletes will be selected for the Olympic Games.

There appears to be a relationship between the location of a country and the number of medals won for summer and winter games. Countries at higher latitudes in relation to the equator tended to win more

medals at the Winter Olympics. Countries that were more successful at the Summer Olympiads were closer to the equator. Perhaps the difference might be related to climate. The countries at higher latitudes tend to have more snow. Snow sports are a major part of the Winter Olympics. The Summer Olympiads are not so dependent upon climate and temperature as they can be practiced in indoor facilities.

Students will first find the countries that were winners in the Winter Olympics and the Summer Olympiads. They will compare this data to isotherm maps for the months of January and July, winter and summer seasons.

An isotherm map shows general global temperature patterns. This portion of the activity will help the students visualize global temperature ranges as well as help them understand how latitude as well as season can influence temperature patterns. The coloring of the map using the scale helps the students to see the temperature patterns.

Management
1. To provide students with the most distinct map, make copies directly from the original map. Each group will need two world maps and the two isotherm maps.
2. Choose a color code for the isotherm maps—cool colors for the lower temperatures and warm colors for the higher temperatures.
3. Place students into groups of four. One pair will plot the summer medal winners and the other the winter winners.
4. The tables show the top-performing countries from the most recent Summer Olympiad and Winter Olympics. The list is slightly larger for the Summer Olympiad since more countries enter and more medals are awarded.
5. The generalized isotherm maps are to help the students see general temperature patterns based on latitude and season.

Procedure
1. Ask the *Key Question* and state the *Learning Goals*.
2. Distribute the two world maps to each group. One student pair will record the medals for the Summer Olympiad and the other for the Winter Olympics.
3. Direct the students to use a colored pencil to shade in the countries on the maps and record the number of medals won by each country. Encourage the students to use the atlas to check the location of the countries.
4. Distribute the isotherm maps. Assign the pair of students who colored countries for the Summer Olympiad to color the July isotherm map. Have the other pair, the ones with colored the Winter

Olympic medal-winning countries, color the January isotherm map. Direct the students to use the color key you have chosen (see *Management 2*).
5. Ask the students to compare the maps they have color-coded and look for patterns. (The students should see that the countries that won the most winter medals tend to be higher latitude countries and that the countries that win more summer medals are less influenced by latitude position.)

Reflecting on Learning
1. What patterns do you notice by looking at the four maps?
2. Some countries, like the United States, are successful during both. What are some of the reasons that could explain this?
3. What patterns do you think we would find if we plotted all the winners?
4. What other factors might influence the number of medals won by a country?
5. How did coloring the two isotherm maps influence your thinking about latitude and temperature?
6. If you were to examine the location of the host site for the winter and summer games, where do you think you would find most of the winter games? Would you find the same pattern for the summer games?

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an Olympic Latitude

Find and color these countries on the map.

Medal Totals
2000 Summer Olympic Games
Sydney, Australia

United States	97
Russia	88
China	59
Australia	58
Germany	57
France	38
Italy	34
Cuba	29
Great Britain	28
South Korea	28
Romania	26
Netherlands	25
Ukraine	23

Find and color these countries on the map.

Medal Totals
1998 Winter Olympic Games
Nagano, Japan

Germany	29
Norway	25
Russia	18
Austria	17
Canada	15
United States	13
Finland	12
Netherlands	11
Japan	10
Italy	10

an Olympic Update

Summer, Winter _____ **Medal Winners**

an Olympic Latitude
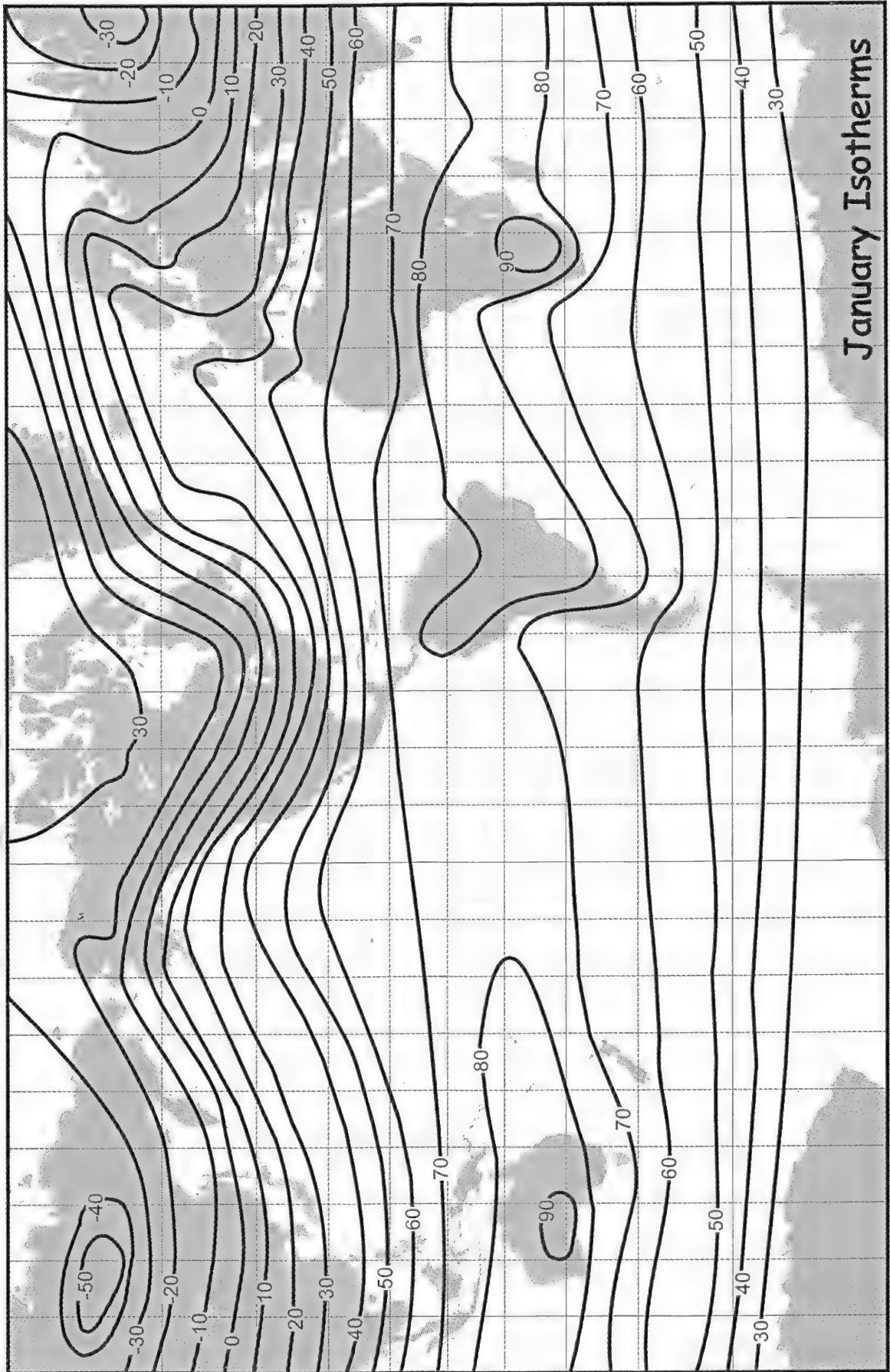
January Isotherms

below zero	0–20	20–40	40–60	60–80	80 and above

an olympic latitude

July Isotherms
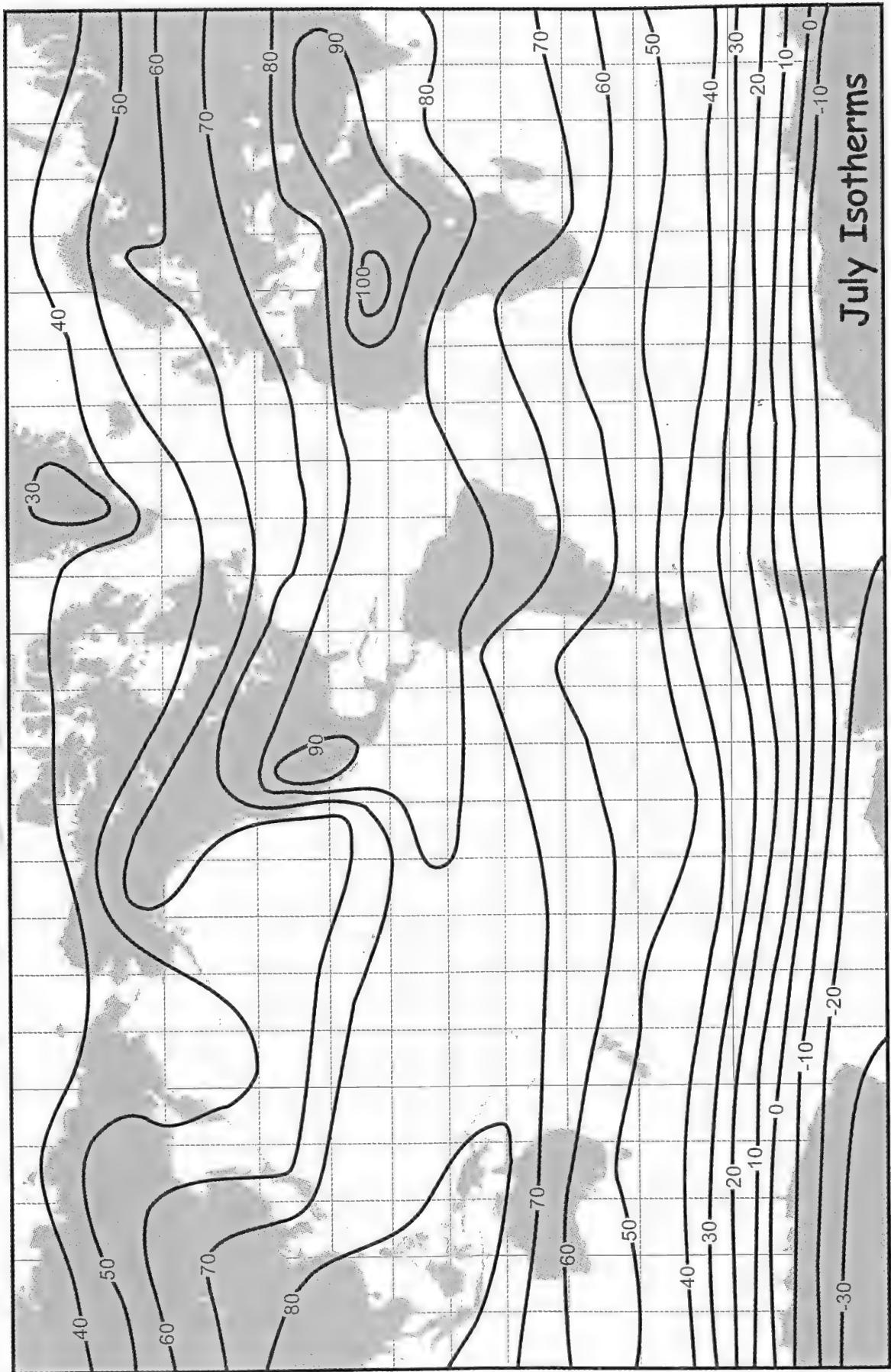
below zero	0–20	20–40	40–60	60–80	80 and above

OLYMPIC PARK BOBSLED TRACK

Part Two

How does the speed of a bobsled change in a race?

by Sheldon Erickson

Topic
Algebraic Thinking

Learning Goals
Students will:
1. use data from the 2001 World Cup Bobsled Race results to determine the average speeds on different segments of the race,
2. display the data on a distance versus time graph, and
3. learn that a steeper slope on the graph represents a greater speed or rate of change.

Key Question
How does the speed of a bobsled change in a race?

Guiding Documents
Project 2061 Benchmarks
- *In the absence of retarding forces such as friction, an object will keep its direction of motion and its speed. Whenever an object is seen to speed up, slow down, or change direction, it can be assumed that an unbalanced force is acting on it.*
- *Mathematical statements can be used to describe how one quantity changes when another changes. Rates of change can be computed from magnitudes and vice versa.*
- *Graphs can show a variety of possible relationships between two variables. As one variable increases uniformly, the other may do one of the following: always keep the same proportion to the first, increase or decrease steadily, increase or decrease faster and faster, get closer and closer to some limiting value, reach some intermediate maximum or minimum, alternately increase and decrease indefinitely, increase and decrease in steps, or do something different from any of these.*

NRC Standards
- *If more than one force acts on an object along a straight line, then the forces will reinforce or cancel one another, depending on their direction and magnitude. Unbalanced forces will cause changes in the speed or direction of an object's motion.*
- *Mathematics is important in all aspects of scientific inquiry.*

NCTM Standards 2000*
- *Explore relationships between symbolic expressions and graphs of lines, paying particular attention to the meaning of intercept and slope*
- *Use graphs to analyze the nature of changes in quantities in linear relationships*
- *Solve simple problems involving rates and derived measurements for such attributes as velocity and density*

Math
Algebra
 rates
Graphing

Science
Physical science
 speed
 forces

Integrated Processes
Observing
Collecting and organizing data
Predicting
Interpreting data
Inferring

Materials
Student pages

Background Information
  The 2002 Winter Olympics in Salt Lake City should be exciting for the U.S. bobsled and skeleton teams that completed their most successful season in 2000-2001. The athletes collected 26 medals on the World Cup circuit and at the World Championships.
  The women's bobsled teams would love to see a repeat of the World Cup Finale where they swept the top three spots, an unprecedented accomplishment. With 13 medals—six gold, four silver, and three bronze—they are favored to win an Olympic medal in 2002.
  The men's and women's skeleton teams are ranked first and second in the world. They won 11 medals in the season and are in the pursuit of metal at the Olympics.
  The men's bobsled team had the best finishes in years, earning gold and bronze medals. The men
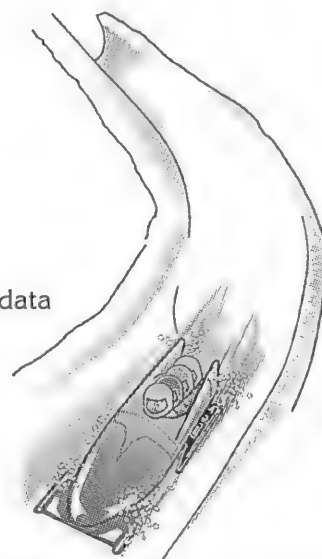
of the four-man bobsled team hope their win of the World Cup season finale is a foreshadowing of the Olympic outcome.

As in all races, the bobsled is determined by elapsed time. The finishes of bobsled and skeleton events are decided by hundredths of a second. It is critical for racers to determine when and where along the track they are losing time. For this reason, the track has been split into segments where time is measured with electric switches.

Speed is not used to determine who wins the race, time is. Although a sled may have been fastest at a certain spot, it may have been going slower at other times. Races are about average speed, not instantaneous speed.

Split times allow racers to look at different segments of the race and determine in what segments they could improve their average speed. The average speed for each segment can be determined by dividing the length of the segment by the time it took to travel that distance.

The concept of average speed begins to make sense as students compare numeric and graphic representations to their experience. By watching a video clip of a bobsled run, students understand the acceleration of the sled. They can relate it to their experiences on roller coasters or sledding. By taking the length of the track and dividing it by run time, the average speed of the sled can be determined. As students familiar with graphing plot the starting and ending times and distances, they are quick to disagree with the representation. The straight line that is plotted shows the sled was traveling a constant speed. As they graph and calculate the split speeds, they will agree that the average speed increases as the sled goes down the hill. As they calculate and record the average speed for each split, they will quickly see the relationship of the slope of the graph to the speed of the sled.

The graphs generated by all the bobsled events will look very similar. They will show acceleration through the first two or three segments and then will indicate a constant speed as the resistive forces of friction and turning balance gravity. The graphs will differ slightly reflecting the forces of physics. The skeletons have a greater speed initially because of the speed from the push start. The bobsleds have a greater maximum average speed because their greater weight must be balanced with a relatively smaller air resistance. The bobsleds start slower than the skeletons, but reach a higher average speed, overtaking the skeletons in the second and third segments.

Management

1. The computer's spreadsheet graphing capability is excellent for this activity. The ability to quickly adjust the scale allows students to look more closely at how the events shape up differently. Students can see the slightly different initial accelerations and when different events reach their maximum average speeds. Data charts for this purpose can be downloaded at the AIMS site (http://www.aimsedu.org/) in several forms.
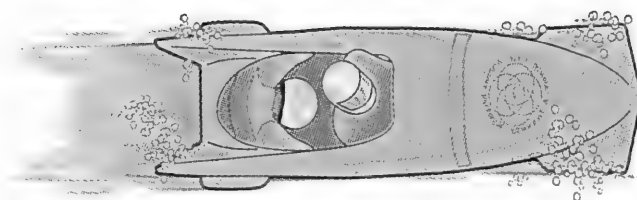
2. Before the activity, you may wish to show segments of the video *Cool Runnings* or the "Point of View" (POV) Quicktime movie from the Olympic website (see *Extensions*), to help students become familiar with a bobsled race.

3. Feet measurements have been included along with the metric measures used in the Olympics. Most students have no "feel" for meters per second and the teacher may have students calculate speeds in feet per second and convert it to miles per hour.

4. All five events are listed in the data chart. You should determine how many events to have students calculate speeds and graph. Two is often enough to see patterns and compare differences.

Procedure

1. Show some video clips of a bobsled run (see *Management*) and discuss the *Key Question* with the class.

2. Distribute the student pages and have the students calculate and graph the average speed for the whole race.

3. Discuss with the class what the graph communicates and have them consider if it matches their experience and observations.

4. Have the students calculate and graph the speed of each split of the race.

5. Discuss with the class how the graphs differ and which is a better representation of the event.

6. Have students calculate split speeds of other events and graph them on the same graph.

7. Discuss how the speeds in the graphs differ and how that difference is represented in the graph.

Discussion

1. From looking at the videos or from your own experience, how do you expect the speed on the bobsled to change as it is ridden down the track? [faster and faster]

2. What does the straight line of the average speed graph say about the speed of the sled? [It does not change.]

3. How do the split speeds change through the race? [faster for the first two or three segments, then little change]
4. How do the changes in split speeds show up on the graph? [getting faster = steeper slope, little change = horizontal line]
5. What are the similarities and differences in the graphs of different events? What do they tell us about how the events differ? [similar shape, slightly different starting times, different maximum average speeds]
6. What might cause these differences in speeds? [weight, air resistance]

Extensions

1. Results from the Olympic runs will be posted by the following day at the following Internet site (http://www.bobsleigh.com/Results/results%20index.htm). Have students calculate and graph the Olympic results to see how much they varied from the 2001 World Cup results.

2. Before the games students might want to do more research on the Winter Olympics and the bobsled and skeleton events. The following web sites are informative:

Olympic site for education
http://www.uen.org/2002/

General Olympic Information
www.slc2002.org
www.slc2002.org/pov_video/index.html

International bobsled organization
http://www.bobsleigh.com/index.htm

United States bobsled organization
http://www.usabobsledandskeleton.org/

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OLYMPIC PARK BOBSLED TRACK Part Two

How does the speed of a bobsled change in a race?
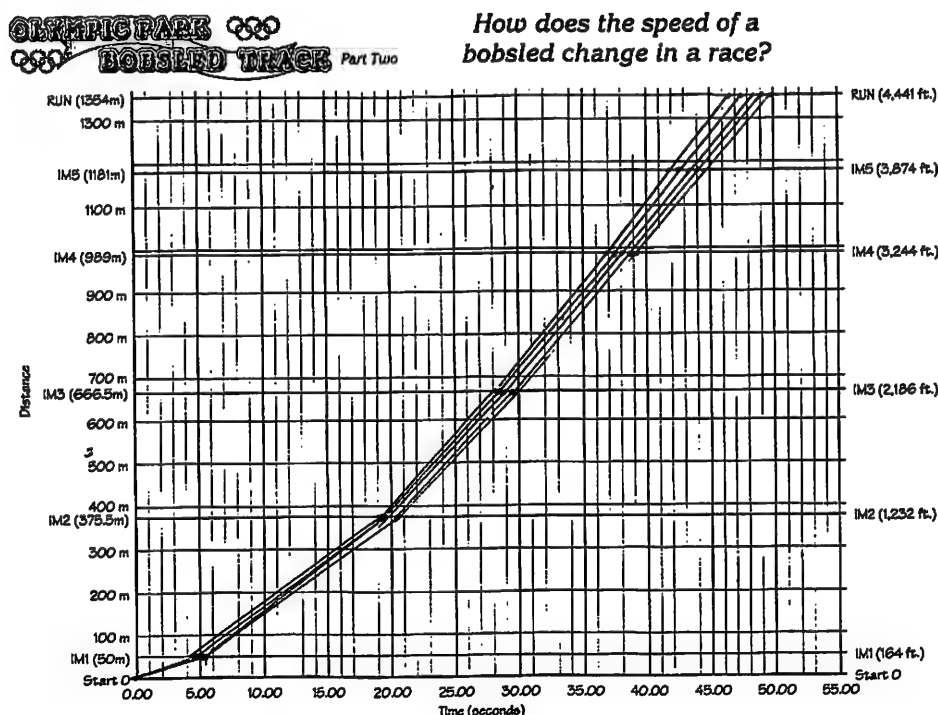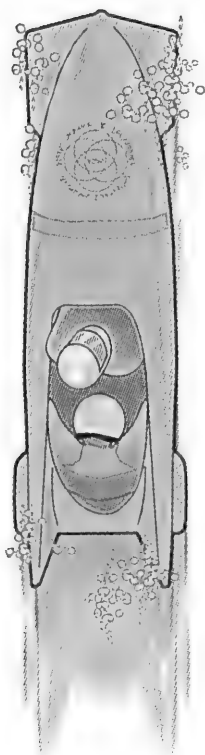
2001 World Cup Bobsled Results - Olympic Park - Park City, Utah

Split Times

Events	Track Position Timer Distance (meters) Distance (feet)	Start Start 0 0	Start End IM1 50 164	Exit 5 IM2 375.5 1232	Ent. 10 IM3 666.5 2186	Exit 12 IM4 989 3244	Ent. 15 IM5 1181 3874	Finish Run 1354 4441
	Women's Bobsleigh World Cup Park City, Utah Feb. 17, 2001 First Place USA1 – Racine, Davidson	0	5.45	20.58	29.58	38.77	44.03	49.08
	Men's 2-Man Bobsleigh World Cup Park City, Utah Feb. 24, 2001 Fastest Time SUI3 – Gotschi, Reto & Grand, Cedric	0	4.94	19.74	28.54	37.56	42.7	47.58
	Men's 4-Man Bobsleigh World Cup Park City, Utah Feb. 25, 2001 Fastest Time GER1 – Lange, Behrendt, Hoppe, Embach	0	4.85	19.53	28.18	36.93	41.9	46.57
	Women's World Skeleton Tour Park City, Utah Feb. 17, 2001 Fastest Time CAN – Michelle Kelly	0	5.22	20.41	29.56,	39.05	44.52	49.91
	Men's World Skeleton Tour Park City, Utah Feb. 16, 2001 First Place USA – Lincoln DeWitt	0	4.73	19.6	28.67	38.06	43.46	48.65
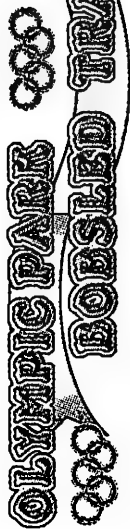
Part Two

How does the speed of a bobsled change in a race?

OLYMPIC PARK BOBSLED TRACK

Part Two

Distance axis (left):
- RUN (1354m)
- 1300 m
- IM5 (1181m)
- 1100 m
- IM4 (989m)
- 900 m
- 800 m
- 700 m
- IM3 (666.5m)
- 600 m
- 500 m
- 400 m
- IM2 (375.5m)
- 300 m
- 200 m
- 100 m
- IM1 (50m)
- Start 0

Distance axis (right, ft.):
- RUN (4,441 ft.)
- IM5 (3,874 ft.)
- IM4 (3,244 ft.)
- IM3 (2,186 ft.)
- IM2 (1,232 ft.)
- IM1 (164 ft.)
- Start 0

Distance

Time (seconds): 0.00, 5.00, 10.00, 15.00, 20.00, 25.00, 30.00, 35.00, 40.00, 45.00, 50.00, 55.00
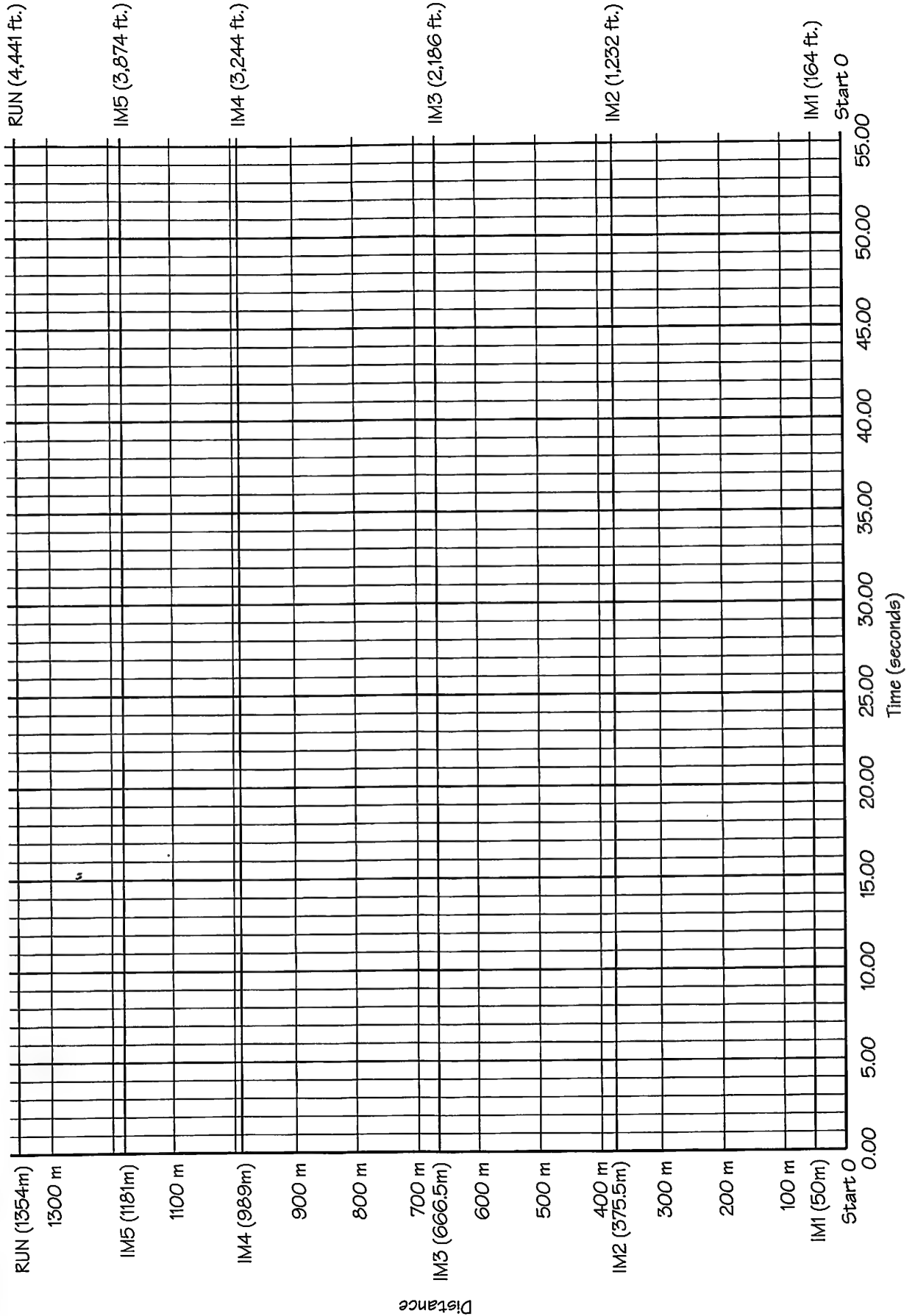
OLYMPIC PARK BOBSLED TRACK

Part Two

UTAH PARK
BOBSLED/SKELETON/LUGE TRACK
BASIC MAP

BOBSLED/SKELETON START
IM 1
CURVE 1
2
3
4
IM 2
5
6
7
8
9
IM 3
10
11
12
13
14
IM 4
FINISH LINE
15
IM 5

Time   Distance

Start

IM1

IM2

IM3

IM4

IM5

Run

| change in distance | change in time | = | average speed |

change in distance / change in time = average speed

Literature Links

by Myrna Mitchell

Where the Wild Things Are

Maurice Sendak wrote the children's classic, *Where the Wild Things Are,* (Harper & Row. New York), in 1963. Sendak, the youngest of three children, was born in Brooklyn, New York in 1928. His parents were poor Polish immigrants who came to the United States before World War I. Many of his relatives in Poland died in the Holocaust. Maurice himself was sickly as a child. His mother worried constantly about his health and safety. In fact, you may notice that many of his books have a moon somewhere in the illustrations. It symbolically watches over the scene much like his mother peeked out the window to watch over him as a child.

Honored since the first book he illustrated in 1951, Maurice Sendak has illustrated or written and illustrated over 90 books. The list of awards presented to him is far too long to include in this article. It will suffice to say that he has received every major prize for excellence in children's literature, including the Caldecott Medal and the American Book Award.

Although he has produced many books, probably his most famous is *Where the Wild Things Are.* It is one of the ten best-selling children's books of all time. As famous for its illustrations as it is for its story, *Where the Wild Things Are* is a tribute to childhood imagination. Children can't help but identify with Sendak's character Max. He is the type of child who entertains himself by dressing in a wolf suit and chasing his poor dog with a giant fork. Before long, Max's frazzled mother calls him a wild thing and he is sent to his room without any supper. What's a boy to do when he has been sent to his room but to let his imagination take over? Max goes to where the wild things are, of course! Max's room transforms into a forest that grows by leaps and bounds. Soon an ocean appears, complete with a boat for Max.

He then finds himself on the boat headed to a strange land where he's named king of a herd of wild things, all much larger, hairier, and meaner looking than he ever pretended to be. After raising a ruckus with the fearsome "wild things," Max begins to feel lonely and sails for home. When he returns from his imaginary journey, he finds that the one who "loves him the most" has left something for him to eat, and it's still hot! What a wonderful way to show that monsters can be conquered and children who misbehave can be forgiven.

Not only is the story well written in Sendak's style of run on sentences, but the artwork is imaginative and richly detailed. Sendak's colorful illustrations (perhaps his best) are beautiful. Each turn of the page brings the discovery of a new wonder. To emphasize the vividness of Max's dream, the pictures grow in size as Max nears the land of the wild things. They fill the pages while he is there and then diminish once again as he returns home. This captures the joys and fears of childhood so perfectly. It probes the stuff kids' dreams are made of. The wild things, with their mismatched parts and giant eyes manage somehow to be scary looking without ever really being scary; at times, they're downright hilarious.

No matter how old you are, the excitement of the story of *Where the Wild Things Are* is infectious and will hold you, as well as your students, enthralled. It truly is a delightful treasure that serves as a constant reminder of the power of the imagination whether you are young or old. Read *Where the Wild Things Are* and laugh with your students.

Suggested Language Activities

- Have the students draw their favorite character in the story, write a sentence to describe that character, and choose a good nickname for the character.
- Have students create story action ropes showing cause and effect relationships. For example, one rope may have pictures of Max misbehaving on one end and a picture of Max going to bed without dinner on the other end.
- Create wild thing puppets or potato characters and act out the story.
- List major events that took place in the story on sentence strips. Choose one event and ask the children to identify whether the event took place in the beginning, middle, or end of the story. The children can then sequence the other events by identifying whether they took place before or after the benchmark event.
- With the class, create a map on butcher paper of Max's trip that depicts the route he took. Create a legend based on the things Max saw during his trip, such as trees, water, land, and wild things. Show children how the legend is like a map "key" since it "unlocks" the meaning of the map's symbols or drawings.
- Ask the students to respond to the question, "If Max were dressed as a lamb, how would he have behaved differently?"
- Write a new title for the story.
- Have the students write about an experience they have had that is similar to an experience in the story.
- For word work: List 10 two-syllable and five three-syllable words from the story. List five words from the story in alphabetical order. Write a synonym for five words from the story. Write an antonym for five words from the story. List five words from the story that have prefixes or suffixes. Underline the root (base) words. Make a list of compound words found in the story.
- Before reading the story, go on a picture walk through the book and ask students what they think the story is about. Have them imagine what a land with wild things might sound like.

- As a class write a sequel to the book. For instance, Max could travel by plane to where the fluffy things are.
- Using a pocket chart, classify things in the story as real or imaginary.
- Write the following five sentences on the board:
  1. Max is wild and is sent to his room.
  2. Max is sent to where the wild things are.
  3. Max tames the wild things and becomes like them.
  4. After the rumpus, Max becomes lonely.
  5. Max sails home to his dinner and to the people who love him.

     Divide the class into collaborative reading groups. Give each group six 5- x 8-inch cards, each with holes punched in both top corners. Let students decide which of the five events each student will illustrate on a card. Have students copy the sentence that describes their illustration on the back of the card. Have students make the sixth card a title card. Be sure students sign their names on the back of the title card. After they are done, weave the plot together by threading yarn through the holes in the cards.
- Have the students identify the author's message.
- Ask the students to add a sentence to the end of the story.

Suggested Math and Science Activities
- "Aluminum Foil Boats" *(AIMS Newsletter, Vol. II, No. 3)*
- "What Do You Think Will Float" *(Spring Into Math and Science)*
- "Floating and Sinking" *(AIMS Newsletter, Vol. I, No. 4)*
- "Floating Fruits" *(Spring Into Math and Science)*
- "Sizing Up Sails" *(AIMS, Vol. X, No. 3)*
- "Creature Features" *(Math + Science a Solution)*
- "The Tub That Spilleth Over" *(AIMS, Vol. VIII, No.6)*
- "Water Facts" *(Water Precious Water)*
- "Where is Water?" *(Primarily Earth)*
- Using an inflatable globe, toss the globe to 10 students in the class, and have the students identify whether their right thumb ends up on land or water. Tally the results and discuss the fact that the Earth's surface has more water than land.
- Supply the children with pieces of material like pieces of cotton, plastic, wool, aluminum foil, etc., eyedroppers, and a cup of water. Ask them to identify which materials absorb water and which do not.
- Have the students create a clay model of the island that Max visited. Use this as an introduction to landforms.

Following this article, you will find an activity that was written specifically for use with this book.

Creature Combinations

by Myrna Mitchell

Topic
Picture combinations

Key Question
How many different creatures can be made from three sets of heads, bodies, and legs?

Focus
Students will explore the number of *creature combinations* that can be made from three sets of heads, bodies, and legs.

Guiding Documents
Project 2061 Benchmarks
- *Numbers and shapes can be used to tell about things.*
- *Numbers can be used to count things, place them in order, or name them.*

NRC Standard
- *Use data to construct a reasonable explanation.*

NCTM Standards 2000*
- *Use concrete, pictorial, and verbal representations to develop an understanding of invented and conventional symbolic notations*
- *Represent data using concrete objects, pictures, and graphs*
- *Recognize reasoning and proof as fundamental aspects of mathematics*
- *Make and investigate mathematical conjectures; develop and evaluate mathematical arguments and proofs*
- *Select and use various types of reasoning and methods of proof*

Math
Math patterns
Algebraic thinking
Combinations

Integrated Processes
Observing
Comparing and contrasting
Classifying
Predicting
Collecting and recording data
Interpreting data

Materials
Where the Wild Things Are by Maurice Sendak
Glue
Student pages (see *Management 1*)
Construction paper, 12- x 18-inch, one sheet per student
Bulletin board paper (see *Management 1*)

Background Information
In this activity, students are challenged to discover all the possible ways that three heads, three bodies, and three feet can be combined to create creatures. This task develops an understanding of combinations, as well as the ability to solve problems in a systematic way. A combination is an arrangement of items in which order is unimportant. That is to say: two red socks and one blue sock is the same as one red sock, one blue sock, and one red sock.

To successfully solve the problem given in *Part Two* of this activity, students will be challenged to utilize systematic problem-solving techniques. They will quickly learn that using a trial and error method of problem solving is not as efficient as developing a systematic way to find all possible combinations of heads, body parts, and legs.

One such strategy might be to find all the possible body and leg combinations for the first head, and then to find all of the possible body and leg combinations for the second head, etc.

Management
1. Each student will need copies of the creature combination book, and each group of three will need one 36- x 54-inch piece of bulletin board paper and three copies of each photo album page.
2. There are two book pages per student page. Have students cut along the line that separates the two book pages. This line is indicated with a picture of scissors. Students will end up with four pages: one cover page and three pages

of monsters. Have the students staple the four pages together where indicated. Then have them cut along the lines that separate the monsters' bodies into three parts.
3. This activity is divided into two parts. In the first part, because there is no recording, it is easy for students to come up with several possible combinations using trial and error. However, in the second part, it is much more difficult to find all combinations using trial and error. Because of this, it is important to discuss the benefits of a systematic approach before the students begin *Part Two*.

Procedure
Part One
1. Read the story *Where the Wild Things Are* by Maurice Sendak. Ask the students to observe the creatures in the story. Have them describe how they are similar and how they are different.
2. Arrange the class into groups of three. Tell the students that they are going to work together to make a set of creatures.
3. Provide each student with a 12- x 18-inch piece of construction paper. Have the students fold their papers into thirds along the 18-inch dimension. (The papers should be positioned so that the 12-inch edges are at the top and bottom.)
4. Have each student draw a large monster head in the top rectangle of the paper, telling them to stay entirely within that top rectangle.
5. When each student has drawn his or her monster head, have all students trade papers within their groups and draw a monster body in the middle section of the paper they just received.
6. Once the bodies have been drawn, instruct students to trade papers again, and draw monster feet in the bottom section of the paper they just received.
7. Instruct students to cut the three sections of their papers apart. Each group should have three heads, three bodies, and three feet.
8. Allow the students time to explore the various creatures they can make from the different combinations.
9. Discuss the strategies used and the results.
10. Have each student write about the monster that they ended up with. Where does it live? What does it eat? What is it like?
Part Two
1. Ask the *Key Question*. Record the students' predictions.
2. Distribute one set of creature combination book pages to each student. Assist the students as they assemble the books by cutting and stapling the pages together.

3. Distribute the photo album picture pages to each group of three. Explain that the students will be recording all of their combinations by gluing the photo album picture pieces onto the bulletin board paper. Remind them to look closely so that they do not repeat any combinations.
4. Discuss the results and any strategies used to solve the problem.

Discussion
1. How many different creatures were you able to make from the three sets of heads, three sets of bodies, and three sets of legs and feet? [27]
2. What strategy did you use to discover all combinations?
3. How do you know that you have found them all?
4. For those of you that used a strategy, how did you decide upon your strategy?
5. How did your strategy help you to solve the problem more easily? [It allowed me to see what I had already used.]

Curriculum Correlation
Literature
Benjamin, Alan. *1000 Silly Sandwiches*. Simon and Schuster. New York. 1995.

Sendak, Maurice. *Where the Wild Things Are*. Harper & Row. New York. 1963.

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Creature Combinations

by

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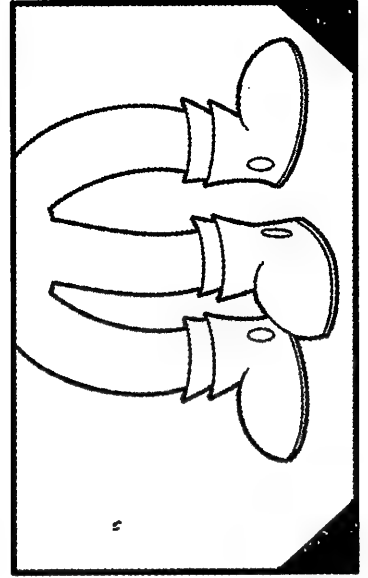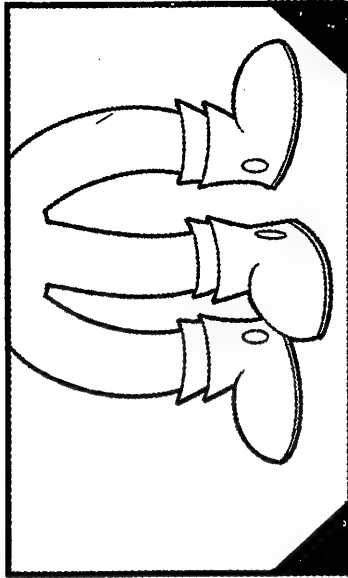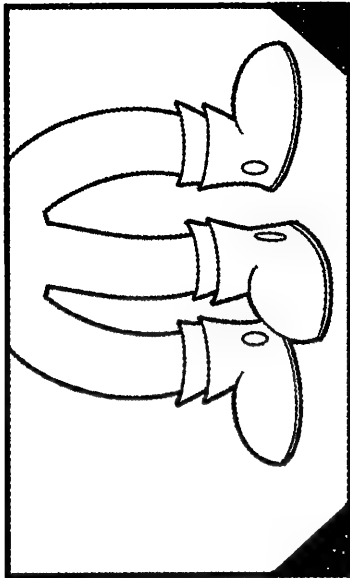Invaders from Space

Creature Combinations
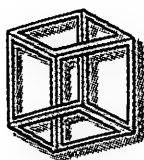
Creature Combinations
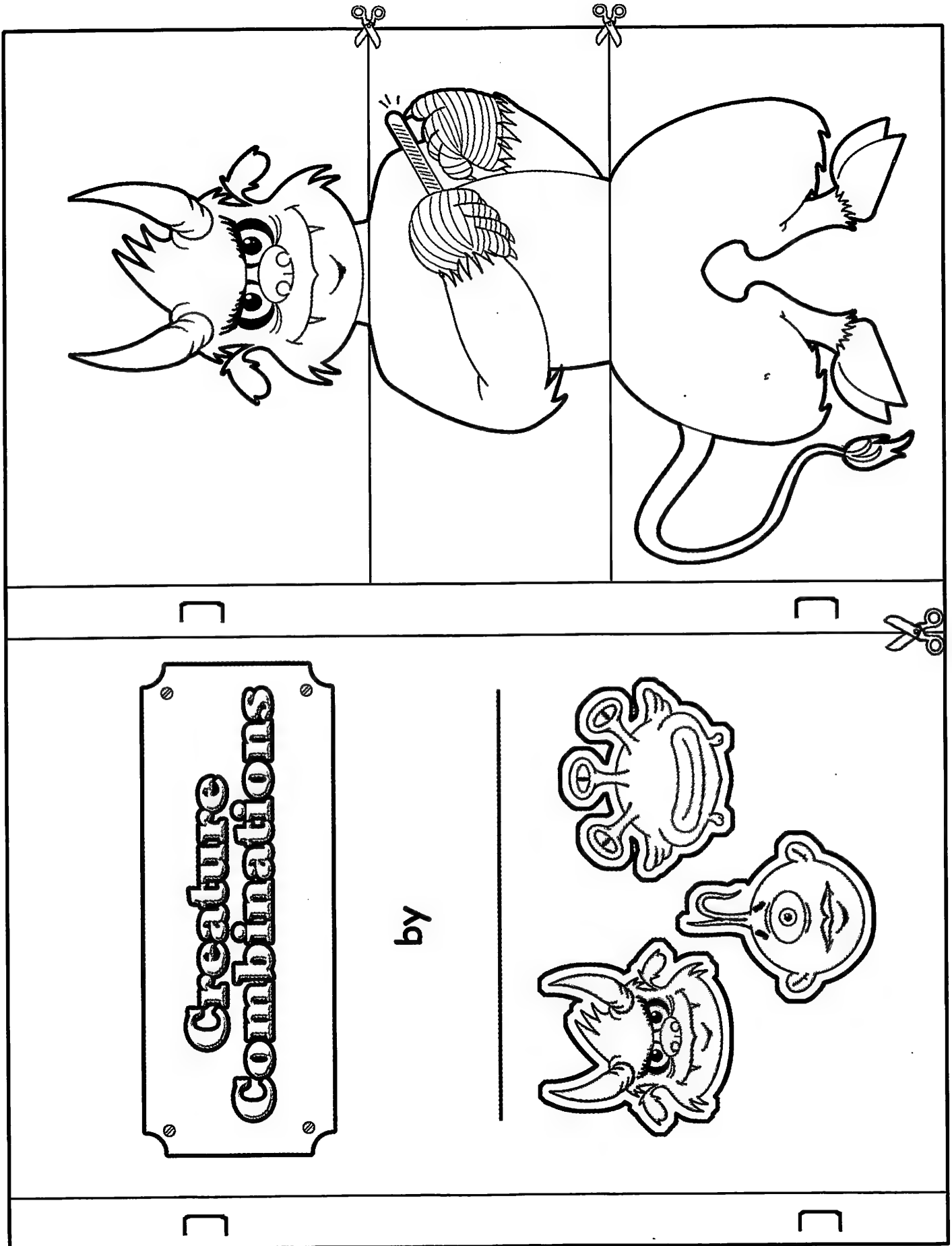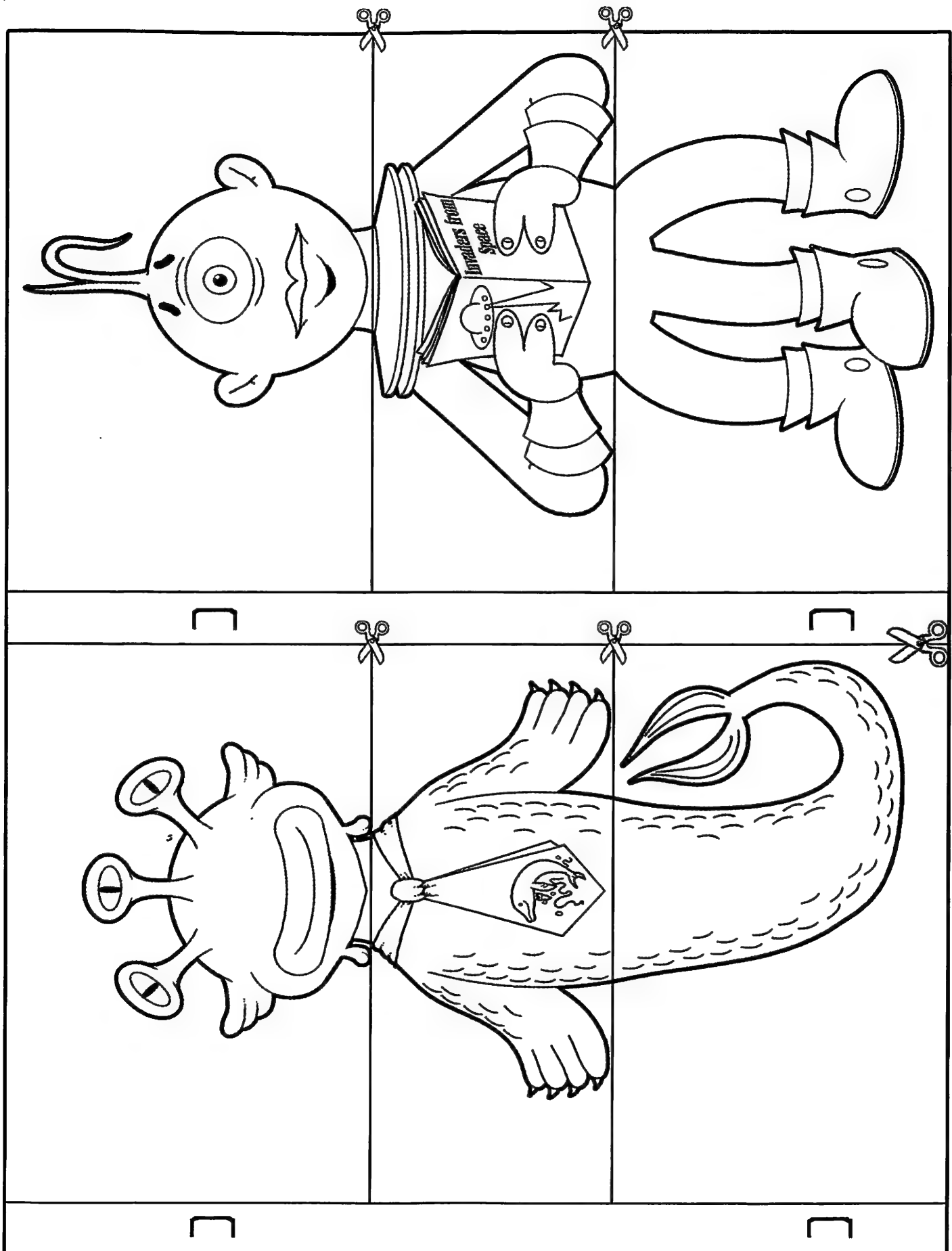
Photo Album Pictures

Creature Combinations

Photo Album Pictures
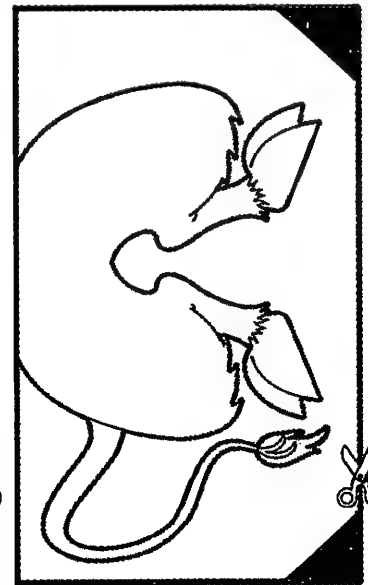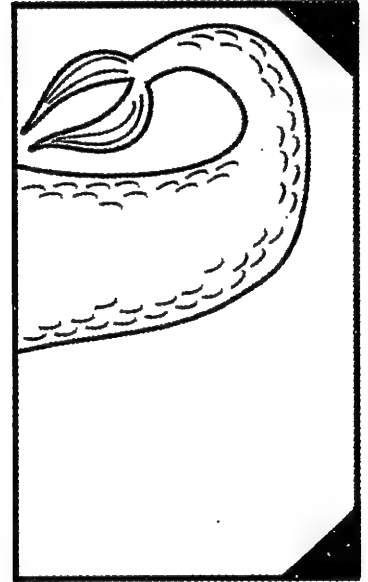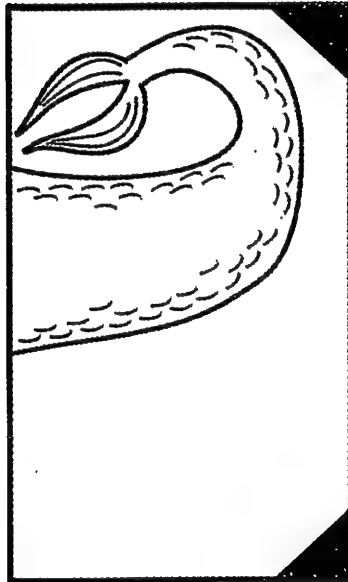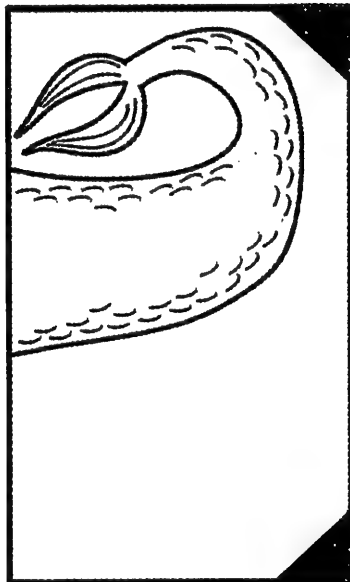
Puzzle Corner
Select-a-Square
by Michelle Pauls

This month the *Puzzle Corner* and *Maximizing Math* activities are designed to be done in conjunction. Students must begin with this activity (*Select-a-Square*) before they will be ready to move on to the following activity (*Sum-a-Square*). These activities will need to be spread over several days in order for students to have sufficient time to thoroughly complete both parts.

In *Select-a-Square*, students are presented with square grids of differing sizes—2 x 2 and 3 x 3. On the first student sheet, they are challenged to select two squares from the 2 x 2 grid and three squares from the 3 x 3 grid so that none of the squares are in the same row or column. In order to assist students in discovering solutions, they should be given small marking chips such as *Area Tiles* or *Math Chips* that they can manipulate in the large grids. Once they find a solution using the marking chips, the solution can be recorded in one of the smaller grids by coloring in the appropriate squares.

A second student sheet follows with questions that challenge students to identify the number of solutions for each level and justify why they believe they have found them all. Students are also challenged to look for patterns, to organize their solutions based on these patterns, and to try to predict the number of solutions for 4 x 4 grid. (As an extension, advanced students can be challenged to discover and record the more than 20 solutions for the 4 x 4 grid.)

A time of class discussion where the questions from the second student sheet are explored together is critical to build the foundation necessary for continuing on to the *Maximizing Math* portion of the activity. As the teacher, it is important for you to have a good understanding of the patterns, even if your students can only grasp them at the most basic level. For this reason, we will break our tradition of not giving the solutions to the *Puzzle Corner* activity until the following month, and discuss them here.
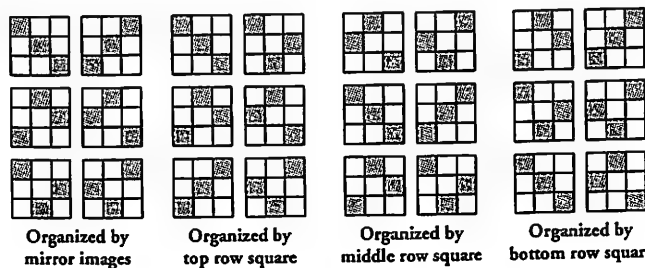

2 x 2 solutions

3 x 3 solutions

As you can see, the number of solutions increases very quickly from one level to the next. While there are only two possible solutions for a 2 x 2 grid, that number triples to six possible solutions for a 3 x 3 grid, and—as previously mentioned—there are more than 20 solutions for a 4 x 4 grid. (The pattern that governs the number of solutions for a given level is fairly advanced, and should not be addressed unless students are very proficient at pattern discovery. The number of solutions for an n x n grid is $n!$ [read "n factorial"]. $n!$ is the product of all of the positive whole numbers between 1 and n.)

The fourth question on the second student sheet asks students to describe three different ways in which they could organize their solutions based on the visual patterns that they discover. These patterns are very useful in helping students determine if they have found all of the possible solutions and should not be overlooked. Encourage students to share their methods with the class and to explain why they chose to organize their solutions the ways they did. Several different methods of organization that your students might use are given below.

| Organized by mirror images | Organized by top row square | Organized by middle row square | Organized by bottom row square |

Each of these methods provides a check to help students determine if they have discovered all of the solutions. As you can see in the first set of solutions, each grid has a mirror image. Once this is discovered, students can quickly generalize that the total number of solutions must be even, and that each solution should have a pair. This allows missing solutions to be easily identified and recorded.

Another pattern that can be observed involves the number of times a given square is selected. For example, in the 3 x 3 grids, each of the squares is selected in a total of two solutions. The last three sets of solutions on the previous page are organized based on this pattern. Again, when this pattern is observed, it provides a simple way for students to fill in any missing solutions.

After students have had time to discover and explore all of the solutions for the 2 x 2 and 3 x 3 grids, they will be ready to move on to *Sum-a-Square*, the *Maximizing Math* activity found on the following pages.

Last Month's Puzzle

In *The Missing Piece*, students were challenged to put a series of smaller pieces together to form larger shapes. In each case, one of the pieces was a decoy, and did not belong. The pieces had figures on them and could overlap if the figures on the overlapping squares were identical. Shown are the pieces and solution for each shape, as well as the extra shape that can be formed by all of the *missing* pieces. In each case, the individual pieces have been given shading to indicate their position. Overlapping squares and the *missing* pieces have no shading.


Original pieces   Solution   *Missing* piece

Original pieces   Solution   *Missing* piece
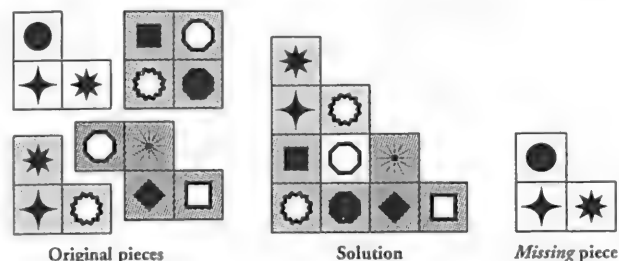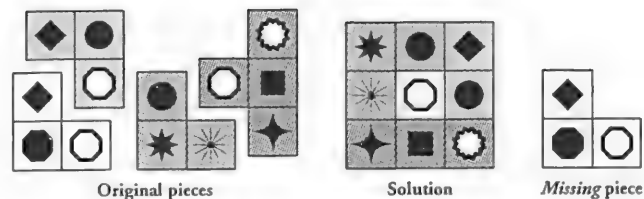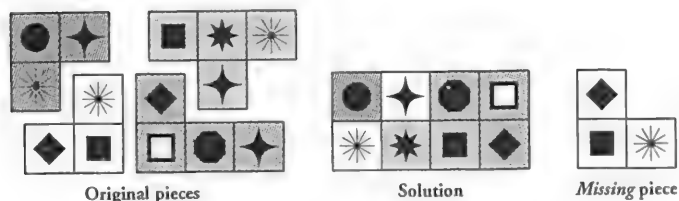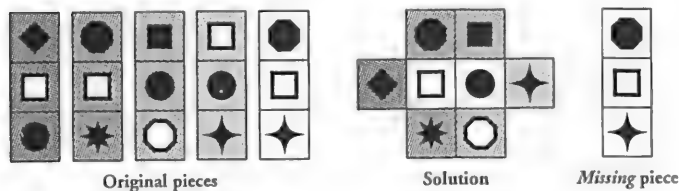
The four *missing* pieces can be assembled to form a second staircase as shown below.

Missing pieces   Extra shape

Original pieces   Solution   *Missing* piece

Original pieces   Solution   *Missing* piece
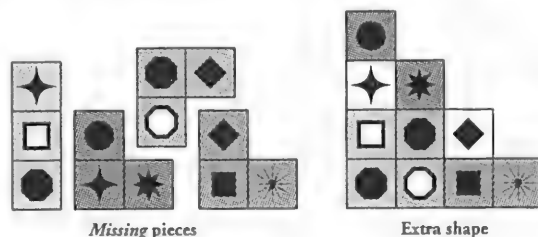
SELECT·A·SQUARE

Your challenge is to find every way that you can select squares from within each of the grids below so that no two squares are in the same row or co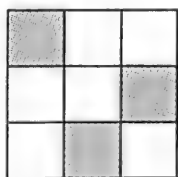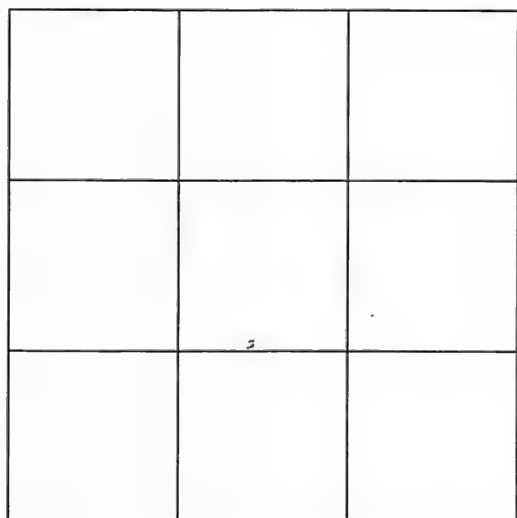lumn. You must select two squares for the 2 x 2 grid and three squares for the 3 x 3 grid. Move your marking chips around in the large grids to help you discover all of the solutions. Once you find a solution, record it in one of the smaller grids. One solution for each level has been done to get you started. (You may not need every grid.)
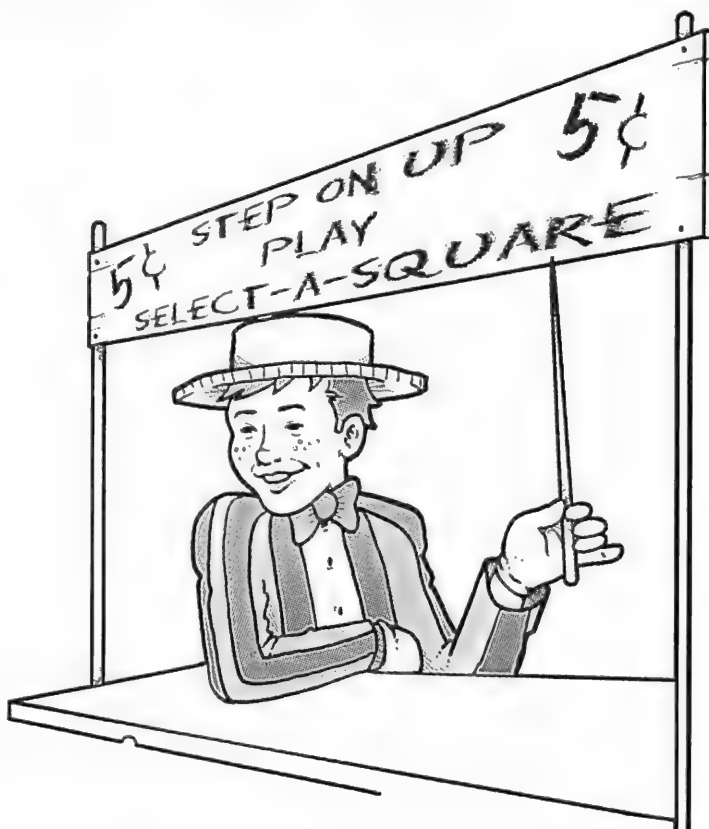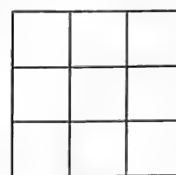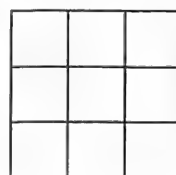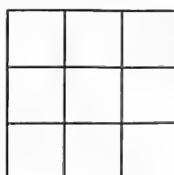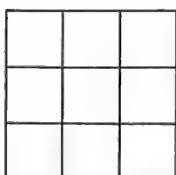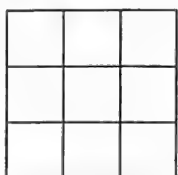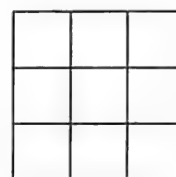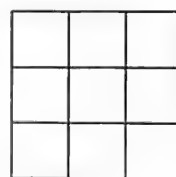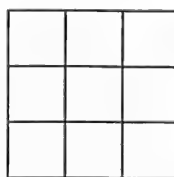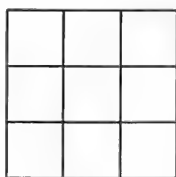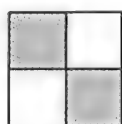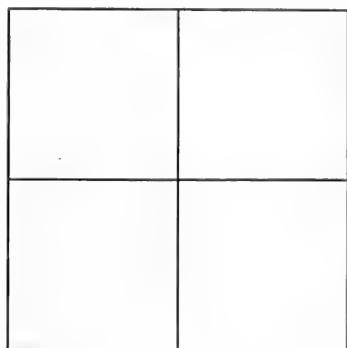
⚒ SELECT·A·SQUARE ⚒

Study your solutions and answer the following questions.

1. How many solutions are there for a 2 x 2 grid? How do you know you have found them all?

2. How many solutions are there for a 3 x 3 grid? How do you know you have found them all?

3. Describe any patterns you see in the way the solutions look. How can these patterns help you determine if you have found all of the solutions?

4. Describe three different ways you could organize your solutions based on the patterns you discovered. Use the grids provided to show one of these ways.
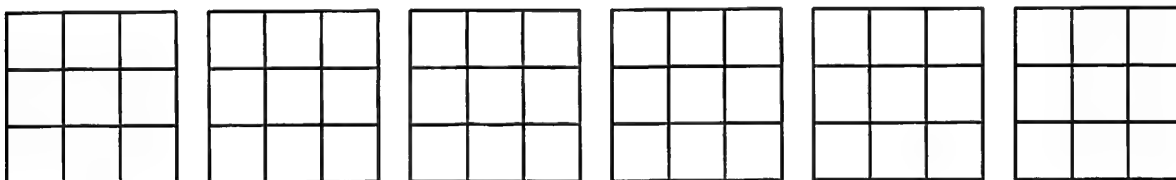
5. How many solutions do you think there would be for a 4 x 4 grid? Why?

Maximizing Math
Sum-a-Square
by Michelle Pauls

This month the *Maximizing Math* and *Puzzle Corner* activities are designed to be done in conjunction. Students must have completed *Select-a-Square*, the *Puzzle Corner* activity, before they will be ready to move on to *Sum-a-Square*. These activities will need to be spread over several days in order for students to have sufficient time to thoroughly complete both parts.

In *Sum-a-Square*, the 3 x 3 grids that were explored in *Select-a-Square* are filled with numbers in such a way that all of the three-square combinations discovered in the previous activity have the same sum. One such grid is shown here.

7	4	9
13	10	15
6	3	8

There are six three-number combinations for this grid in which each number is in a different row and column:

7, 10, 8	4, 13, 8	9, 10, 6
7, 15, 3	4, 15, 6	9, 13, 3

When the numbers in each of these combinations are added together, all of the sums are equal.

$7 + 10 + 8 = 25$ $4 + 13 + 8 = 25$ $9 + 10 + 6 = 25$
$7 + 15 + 3 = 25$ $4 + 15 + 6 = 25$ $9 + 13 + 3 = 25$

The challenge for students on the first student page is to study the number grids and develop an explanation for why they work. A second student sheet asks students to use their discoveries to create their own number grids and test their theories to see if they were correct.

Let's examine why the number grid works the way it does. If you look at the differences between the numbers in the vertical columns and the differences between the numbers in the horizontal rows, some patterns begin to emerge.

Difference

| 3 | 5 |

$13 - 7 = 6$
$10 - 4 = 6$
$15 - 9 = 6$

$13 - 6 = 7$
$10 - 3 = 7$
$15 - 8 = 7$

Difference 6   7

7	4	9
13	10	15
6	3	8

$7 - 4 = 3$
$13 - 10 = 3$
$6 - 3 = 3$

$9 - 4 = 5$
$15 - 10 = 5$
$8 - 3 = 5$

As you can see, the difference between the numbers in the first column and the second column is three, the difference between the numbers in the second column and the third column is five, the difference between the first and second rows is six, and the difference between the second and third rows is seven.

These common differences between rows and columns mean that the array works like an addition table. As you can see in the example below, each of the numbers listed on the outside can be summed to produce the same set of numbers in the interior squares.

It is possible, therefore, to create a number array like those described here in one of two ways—either by choosing a common difference between each row and column and plugging in numbers, or by making an addition table as illustrated above.

Communicating mathematically and being able to express mathematical thinking clearly to others are important NCTM standards at every grade level, so be sure not to neglect a time of class discussion to close the activity. Invite students to share their number grids and the methods they used to create them. Have students justify their methods and offer logical reasons for why their thinking is valid. If both methods for creating the number grids were not discovered, guide the class in a time of group exploration to explore the other possibility.

I hope you and your students enjoy this exploration and the *Puzzle Corner* that precedes it. Please let me know of any questions or feedback you may have regarding this, or any other *Maximizing Math* or *Puzzle Corner* activity.
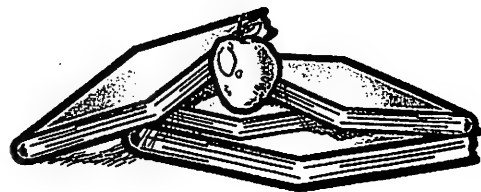
⇒SUM·A·SQUARE⇐

Select three numbers from the grid below so that each number comes from a different row and column. For example, 2, 9, and 3 are each in a different row and column.

2	5	4
6	9	8
1	4	3

1. Use your solutions from **Select-a-Square** to help you record every three-number combination in which all three numbers are in a different row and column.

2. Find and record the sum of each of the number combinations above. What do you notice?

3. Examine the number grid and develop an explanation for why this happens.

SUM · A · SQUARE

Now that you have developed a theory for why the number grid works the way it does, create your own grid to test this theory. Use the space below to record your work, showing each appropriate three-number combination and the sum.

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SPILLS and RIPPLES

Los Alamos

Grades 5 - 12
ISBN 1-881431-83-5
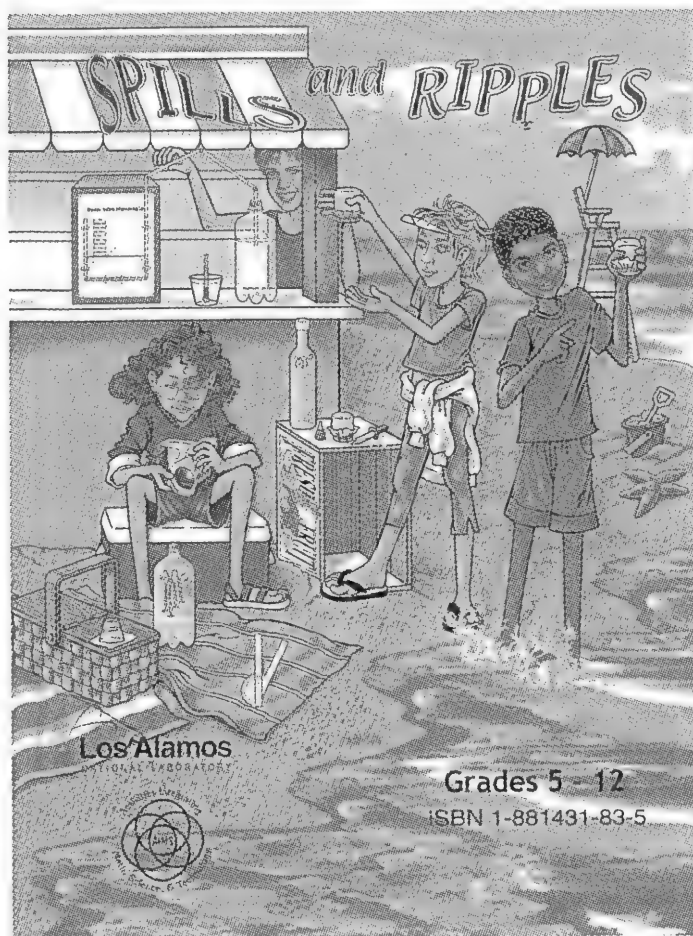
Spills and Ripples is an innovative, exciting, and wet set of investigations designed to arouse curiosity about fluid dynamics. Students improve their understanding of density, pressure, and surface tension by learning to control boundaries between fluids, to manipulate Cartesian divers, and to construct low-cost instruments like a hydrometer and manometer.

Science Research as Toddlers' Play

Toddlers learn by answering their own unspoken questions. They observe an event that excites their curiosity and they devise experiments to explore and learn how it works. For example, the one-year-old that happens to knock a cup off a table will be impressed by the "Wham!" it makes upon impacting the floor. After the cup is returned to the table, the toddler will again knock it off, deliberately this time. Toddlers are usually willing to repeat this experiment far longer than a parent's patience to keep picking up the cup and replacing it on the table. The toddler has non-verbally asked a series of questions: Does the cup always hit the floor and make an exciting noise? Does the cup always fall down? The toddler conducts experiments to learn whether the answer is "yes" or "no" to each question.

Indeed, that is also the purpose of scientific experiments: to determine whether the answer to a question is yes or no. When an experiment yields the answer "maybe" or "sometimes," the result is less valuable than a simple yes or no. Learning to ask good questions and how to answer them takes practice. Scientists, like toddlers, need to develop two important skills: how to ask questions and how to answer questions. *Spills and Ripples* is intended to motivate the development of both of these skills. Because Rayleigh-Taylor Instability is usually unfamiliar to students (and teachers), they can improve their skill at asking yes-no questions about a new event, just as they did many years ago as toddlers.

Learning how to answer questions scientifically is the purpose of the scientific method. Before considering how to help students learn to answer questions, let's first consider how we teach students to ask questions. The non-verbal toddler is motivated to ask questions based on curiosity and wonder. The cup hit the floor and made a wonderful noise—will it happen again if I hit the cup again?

Older people ask questions for other reasons as well. Perplexing observations are good sources of questions. Watching a magic show prompts queries of "That's incredible! How could he possibly do that?" Becoming confused by apparently non-reproducible events, like weather, is another motivation. Mental models of how things work lead to questions, especially about events that are not consistent with the model. For example, people are accustomed to seeing water spill from a bottle when it is turned upside down. When an inverted, water-filled, sample-size bottle of mouthwash doesn't spill, the usual model of spilling seems inadequate. Consequently more questions come to mind: Is this the only bottle that holds in water when turned upside down? Does the bottle shape cause this to happen? Does the opening size matter? Will the water come out if the bottle is squeezed? These and other questions arise from an event that contradicts people's experience-based expectations.

Spills and Ripples is about teaching students to ask questions about simple events involving water spills. The students are confronted with unusual events and offered a simple but unfamiliar idea that explains spilling. Students can then ask questions, which become experiments in *Spills and Ripples,* or they may ask questions that lead to other experiments. Teachers and students are encouraged to think carefully about their concepts of fluid pressure, density, surface tension, and interface, and then use these basic experiments as springboards to check out whether these concepts truly "hold water."

Back to the subject of answering scientific questions. The scientific method is simply a framework, a way, for doing this. It starts with a hypothesis, which is basically a question to be answered yes or no. As we know, much of the fun and excitement in science occurs in creating the hypothesis. Science doesn't begin with the hypothesis because we had to do a lot of thinking and observing in order to arrive at a hypothesis. The "hypothesis step" is somewhere in the middle–at the end of asking the question and the beginning of answering it. Modern science provides the discipline to move from framing the question to a decisive method for answering it.

The scientific method continues with the logical steps: design an experiment and gather needed materials; perform the experiment, preferably many times to learn about reproducibility and errors; make observations; then interpret the results; and draw conclusions. History tells us that this method of answering questions works effectively.

—Robert Benjamin
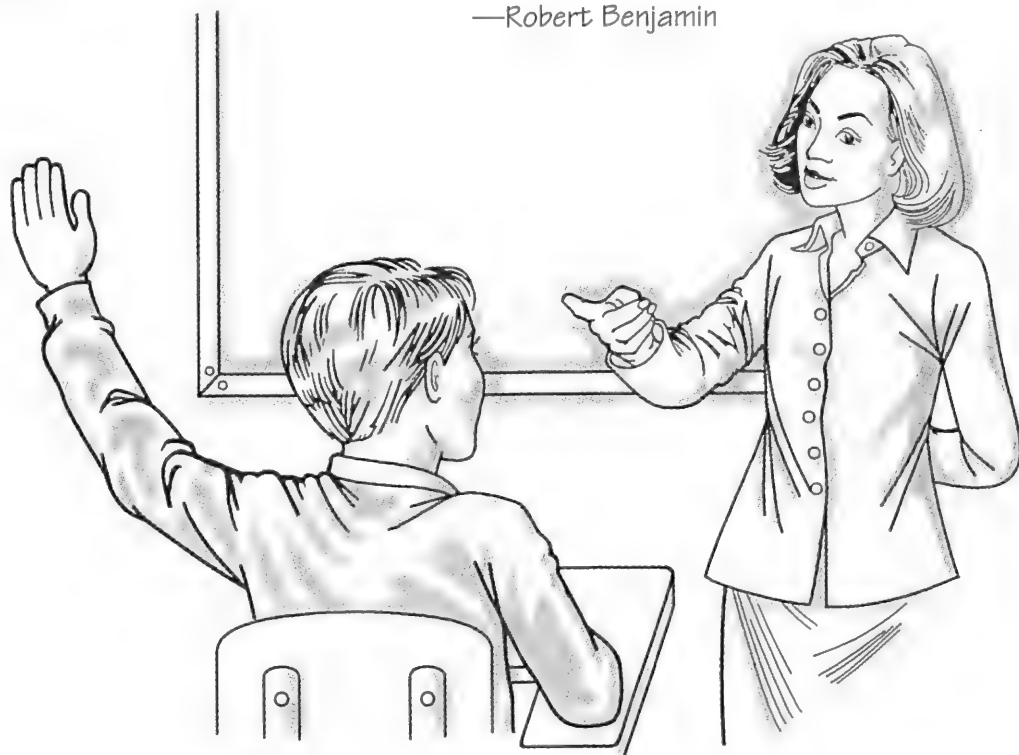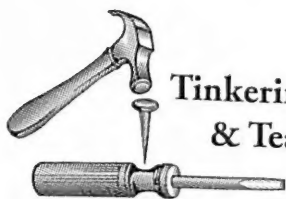
A TRIPLE DENSITY DEMONSTRATOR

by Jim Wilson

A partnership between the AIMS Education Foundation and the Los Alamos National Laboratory has produced a new AIMS publication called *Spills and Ripples*. This book is a collection of fluid dynamics activities that explores the science concepts of liquid, gas, interface, density, pressure, surface tension, force, balanced forces, and Archimedes' principle (floating and sinking).

The principal author of the book is Dr. Robert F. Benjamin, a physicist in the Dynamic Experimentation Division at the Los Alamos National Laboratory in New Mexico. Susan Benjamin, Dr. Benjamin's wife, is a long-time AIMS trainer. Bob (when he's here at AIMS he's known as Bob) has long had an interest in a science principle called *Rayleigh-Taylor Instability* (see definition below) relatively unknown to pre-college students and teachers.

Rayleigh-Taylor Instability (RTI): the growth of ripples (i. e., perturbations) at an interface between two fluids (i. e., gases or liquids) when the higher-density fluid is on top. The growing ripples become finger-like projections or plumes of one fluid into the other. It usually leads to pouring or spilling. It is "driven" by gravity.

Bob's interest in RTI and invitations to visit primary through secondary classrooms as a guest scientist encouraged him to develop materials and techniques for helping students and teachers explore Rayleigh-Taylor Instability (RTI). One way he does this is by asking students questions about ordinary experiences like why water pours from a glass.

One of the activities in *Spills and Ripples* is called *Liquid Rope*. The activity explores what happens when food coloring is allowed to flow from the tip of an eyedropper into a container of clear water containing no currents.

RTI starts the flow from the tip of the eyedropper at the food-coloring/water interface. Assuming there are no strong currents in the water, the denser food coloring on top of the less dense water "falls," in a thin stream, straight down analogous to grains of sand flowing from the spout of a funnel and falling straight down.
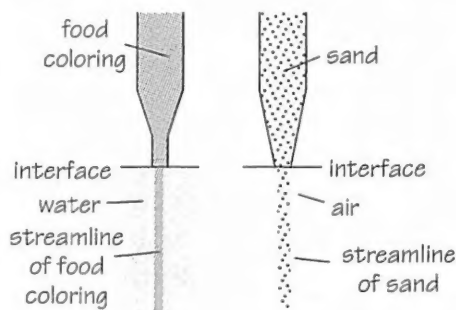
Mixing occurs at the bottom of the container when the stream of food coloring collides with the bottom.
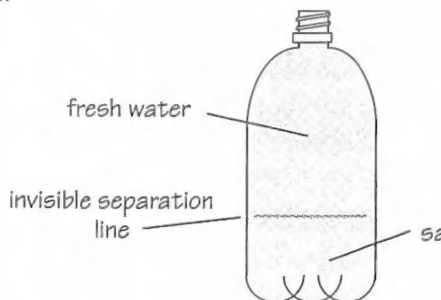
During a phone conversation with Bob about the production process for *Spills and Ripples*, we discussed what we thought would happen if *Liquid Rope* were performed in a bottle containing a layer of fresh water floating on top of a layer of denser salt water. Bob immediately hypothesized that the salt water would act as a density barrier. The food coloring would fall through the fresh water, hit the barrier, and then spread to the sides. In science, observation and experience often lead to forming a hypothesis and then to designing an experiment to

test the hypothesis. Over the phone I told Bob I would tinker a method for getting a layer of fresh water on top of a layer of salt water and report what happens when the falling stream of food coloring hits the salt water.

The experiment answered "yes" to the hypothesis that the salt water would form an impenetrable barrier to the food coloring. The experiment answered "no" to the hypothesis about the food coloring spreading laterally at the saltwater barrier.

What actually happened when I did the experiment was unexpected and stunning. I took a digital photo of the result and emailed it to Bob. He was not immediately familiar with the phenomenon, and we are currently showing the photograph to physicists and engineers that specialize in fluid dynamics.

Later, as I thought about the phone conversation that triggered the experiment, I was struck by how close our conversation paralleled what Bob describes in *Science Research as Toddler's Play* (see article in this issue). I encourage you to read Bob's description of the science process. After you've read Bob's piece, gather the following materials and tools and construct a Triple Density Demonstrator (TDD). I believe you will be amazed at what nature can create from such simple and common materials.

Materials
Plastic two-liter bottle or tall glass bottle
Food coloring
Table salt
Glass or plastic squeeze bottle
Plastic drinking flex straws
Transparent tape

Tools
Eyedropper
Scissors

Constructing the Triple Density Demonstrator
1. Dissolve 80 grams of table salt in 700 milliliters of cold tap water. Pour this solution into a plastic two-liter container. The container will be approximately one-third full. Let the saltwater solution set until it becomes clear. (I prefer to use a tall, narrow-necked glass bottle for this activity. Less salt (40 grams per 350 mL) is required and the

effect is more dramatic. I have used a half-gallon glass pickle jar but it takes four times as much saltwater solution.)

The trick is to get the layer of fresh water on top of the salt water without a lot of mixing. You, or one of your students, may develop a better method than the one that follows. If so, share it with the rest of us.

2. Shorten a flex straw by cutting two inches off the end nearest the flex section of the straw. Bend the shortened end into a J-shape.

3. Use the tapered end of a ball-point pen or pencil to flare the longer end of the straw. Insert the pen into the straw and gently rotate it to produce the flared end.


end of flex straw — ballpoint pen

4. Insert the longer end of the second straw into the flared end of the first straw.

connect
flared end of flex straw — flex straw
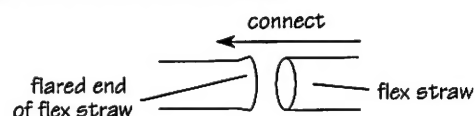
Turn one of the straws until an S-shape is formed. Wrap a piece of transparent tape around the joint.

fresh water in this end
adjust length as needed
tape around joint
this end in bottle
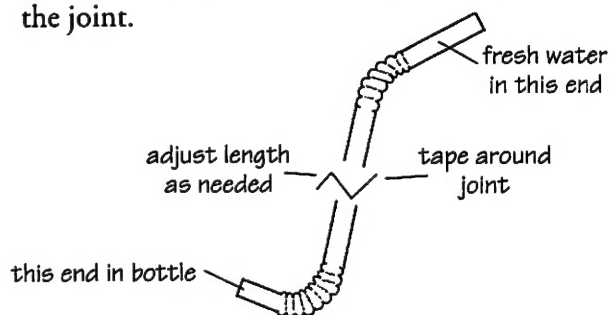
5. Tear or cut the flip-top from the cap of a plastic mayonnaise, mustard, or catsup squeeze bottle that has been emptied and cleaned. Insert one end of the taped straws into the bottle cap. Fill the bottle with water.

mayonnaise squeeze bottle
taped joint
water
remove this piece
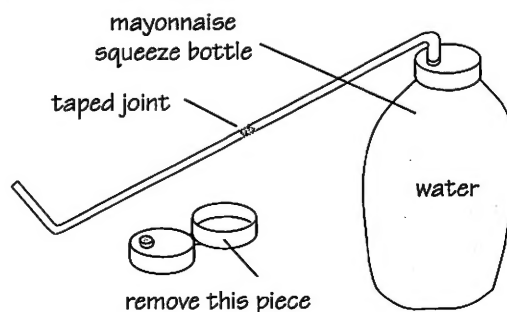
6. Insert the other end of the taped straws into the two-liter bottle and position the J-shaped end of the straw so that it is just above the surface of the salt water. Gently squeeze the plastic bottle and fresh water will flow over the salt water forming a layer of fresh water. Take your time with this operation to minimize the mixing of the fresh and salt water. Let the two-liter bottle sit undisturbed for at least 15 minutes.
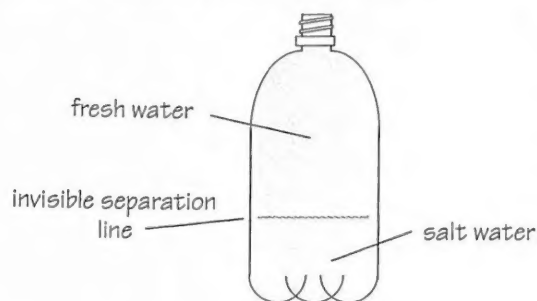
The salt water is as clear as the fresh water so there is no visible separation of the two. Direct observation would report that the bottle is filled with the same, clear liquid. The difference in densities between the fresh water and salt water is not readily evident just by looking at the bottle.

7. Fill an eyedropper with as much food coloring as it will hold. Carefully place the eyedropper, tip down, in the neck of the bottle.
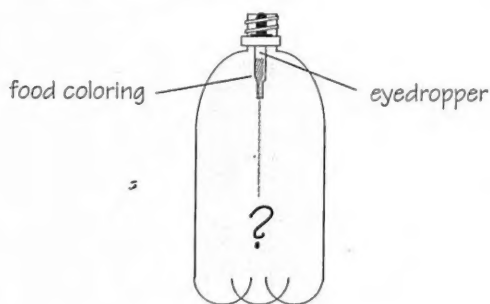
Observe what happens as the denser food coloring falls through the less dense water (Rayleigh-Taylor Instability) and strikes the denser saltwater barrier. Check the bottle every half hour for three hours. I think you will be amazed at what you see.

What a Difference a Decimal Makes

The differences in densities between the fresh water, salt water, and food coloring are small. They differ in the second decimal place. The density of the food coloring is slightly greater than the density of the fresh water. The density of the salt water is slightly greater than either the density of the food coloring or fresh water.
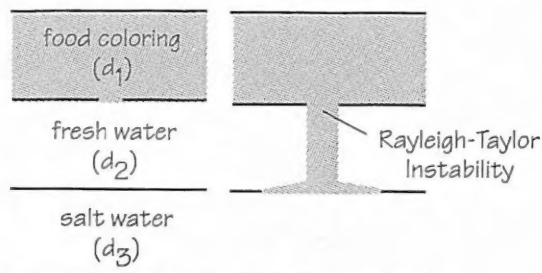
RTI explains the flow of the food coloring through the water and its deflection at the interface between the fresh and salt water. But how do we account for the three-dimensional, tree-limb pattern that develops over time? At this point in time, your hypothesis is as good as ours.
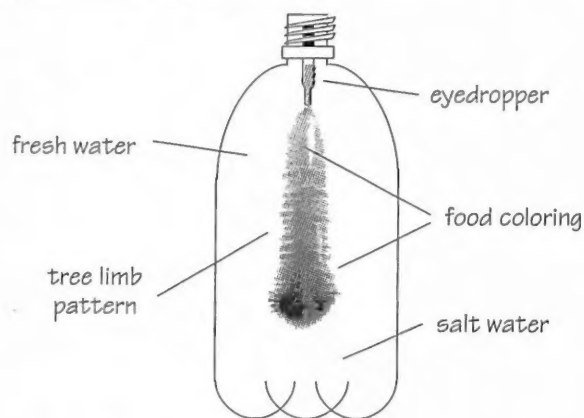
If the bottle is left undisturbed, the food coloring will continue to diffuse through the fresh water for many days and the limb structure will eventually disappear.

Bob and I recently attended the 54th Annual Meeting of the American Physical Society, Division of Fluid Dynamics, held in San Diego, California. We entered color photographs (taken by Dave Youngs, a co-author of *Spills and Ripples*) of the Triple Density Demonstrator in the *Gallery of Fluid Motion* exhibit. A report of what we learned from the fluid dynamics specialists that viewed the demonstrator will appear in this column at a later date.

In the next column we will build a Galton Board and perform three probability experiments using marbles and coins. I think the results of the three experiments will surprise you.

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◁P▷ = Primary Grade Activities　　◁M▷ = Middle Grade Activities　　◁U▷ = Upper Grade Activities

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